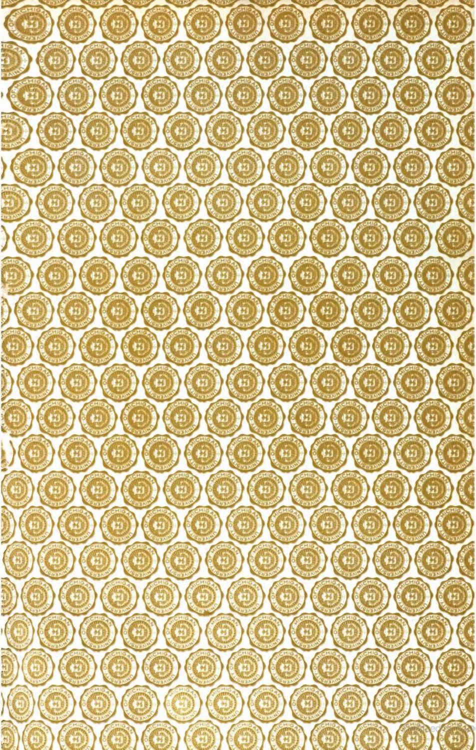


MEMOIRS

OF

THE GEOLOGICAL SURVEY OF INDIA.

Indian Geological survey.

Palæontologia Indica,

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

New Series.

VOL. I.

1.—THE CAMBRIAN FAUNA OF THE EASTERN SALT-RANGE.

By K. REDLICH, Ph.D.,

PLATE 1.

CALCUTTA:

SOLD AT THE

GEOLOGICAL SURVEY OFFICE;

LONDON: KEGAN PAUL, TRENCH, TRÜBNER & CO.

MDCCCXCIX.

PRINTED BY THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA, 8, HASTINGS STREET, CALCUTTA.

1899

MEMOIRS OF THE GEOLOGICAL SURVEY OF INDIA.

VOL. I. Royal 8vo, pp. 309, 1859 (*out of print*). Pt. 1, 1856 (*price* 1 Re.): Preliminary notice on the Coal and Iron of Talchir.—On the geological structure and relations of the Talchir Coal-field.—Gold-yielding deposits of Upper Assam.—On specimens of gold and gold dust from Shué-gween. Pt. 2, 1858 (*price* 2 Rs.): On the geological structure of a portion of the Khasi Hills.—On the geological structure of the Nilghiri Hills (Madras). Pt. 3, 1859 (*price* 2 Rs.): On the geological structure and physical features of the Districts of Bankura, Midnapore, and Orissa.—On the laterite of Orissa.—On some fossil fish-teeth of the genus Ceratodus, from Maledi, south of Nagpur.

VOL. II. Royal 8vo, pp. 341, 1859 (*out of print*). Pt. 1, 1860 (*price* 2 Rs.): On the Vindhyan Rocks, and their associates in Bundelkand. Pt. 2, 1860 (*price* 3 Rs.): On the geological structure of the central portion of the Nerbudda District.—On the tertiary and alluvial deposits of the central portion of the Nerbudda Valley.—On the geological relations and probable geological age of the several systems of rocks in Central India and Bengal.

VOL. III. Royal 8vo, pp. 438. Pt. 1, 1863 (*price* 3 Rs.) (*out of print*). On the geological structure and relations of the Raniganj Coal-field.—Additional Remarks on the geological relations and probable geological age of the several systems of rocks in Central India and Bengal.—Indian Mineral Statistics, I. Coal. Pt. 2, 1864 (*price* 2 Rs.): On the Sub-Himálayas Ranges between the Ganges and Ravi.

VOL. IV. Royal 8vo, pp. 450. Pt. 1, 1863 (*price* 2 Rs.): Report on the Cretaceous Rocks of Trichinopoly District, Madras. Pt. 2, 1864 (*price* 2 Rs.): (*out of print*). On the structure of the Districts of Trichinopoly, Salem, etc. Pt. 3, 1865 (*price* 1 Re.): On the Coal of Assam, etc.

VOL. V. Royal 8vo, pp. 354. Pt. 1, 1865 (*price* 3 Rs.) (*out of print*). Sections across N.-W. Himálaya, from Sutlej to Indus.—On the Gypsum of Spiti. Pt. 2, 1866 (*price* 1 Re.): On the Geology of Bombay. Pt. 3, 1866 (*price* 1 Re.) (*out of print*). On the Jherria Coal-field.—Geological Observations on Western Tibet.

VOL. VI. Royal 8vo, pp. 395. Pt. 1, 1867 (*price* 8 As.): On the Neighbourhood of Lynyan, etc., in Sind.—Geology of a Portion of Cutch. Pt. 2, 1867 (*price* 2 Rs.) (*out of print*): Bokáro Coal-field.—Rámgarh Coal-field.—Traps of Western and Central India. Pt. 3, 1869 (*price* 2 Rs. 8 As.) Tapti and Nerbudda Valleys.—Frog-beds in Bombay.—*Oxyglossus pusillus*.

VOL. VII. Royal 8vo, pp. 342. Pt. 1, 1869 (*price* 3 Rs.): Vindhyan Series.—Mineral Statistics.—Coal.—Shillong Plateau. Pt. 2, 1870 (*price* 1 Re.): Karharbári Coal-field.—Deoghar Coal-field. Pt. 3, 1871 (*price* 1 Re.): Aden Water-supply.—Káranpura Coal-fields.

VOL. VIII. Royal 8vo, pp. 353. Pt. 1, 1872 (*price* 4 Rs.): On the Kadapah and Karnul Formations in the Madras Presidency. Pt. 2, 1872 (*price* 1 Re.): Itkhuri Coal-field.—Daltonganj Coal-field.—Chope Coal-field.

VOL. IX. Royal 8vo, pp. iv, 358. Pt. 1, 1872 (*price* 4 Rs.): Geology of Kutch. Pt. 2, 1872 (*price* 1 Re.): Geology of Nagpúr.—Geology of Sirban Hill.—Carboniferous Ammonites, pp. 65.

VOL. X. Royal 8vo, pp. 359. Pt. 1 (*price* 3 Rs.): Geology of Madras.—Sátpura Coal-basin. Pt. 2, 1874 (*price* 2 Rs.): Geology of Pegu.

VOL. XI. Royal 8vo, pp. 338. Pt. 1, 1874 (*price* 2 Rs.): Geology of Dárjiling and Western Duars. Pt. 2, 1876 (*price* 3 Rs.): Salt-region of Kohát, Trans-Indus.

VOL. XII. Royal 8vo, pp. 363. Pt. 1, 1877 (*price* 3 Rs.): South Mahrátta Country. Pt. 2, 1876 (*price* 2 Rs.): Coal-fields of the Nága Hills.

VOL. XIII. Royal 8vo, pp. 248. Pt. 1, 1877 (*price* 2 Rs. 8 As.): Wardha Valley Coal-field. Pt. 2, 1877 (*price* 2 Rs. 8 As.): Geology of the Rájmahál Hills.

VOL. XIV. Royal 8vo, pp. 313, 1878. Geology of the Salt-range in the Punjab.

VOL. XV. Royal 8vo, pp. 192. Pt. 1, 1878 (*price* 2 Rs. 8 As.): Geology of the Aurunga and Hutár Coal-fields (Palamow). Pt. 2, 1880 (*price* 2 Rs. 8 As.): Ramkola and Tatapani Coal-fields (Sirguja).

VOL. XVI. Royal 8vo, pp. 264. Pt. 1, 1879 (*price* 1 Re. 8 As.): Geology of Eastern Coast from Lat. 15° to Masulipatam. Pt. 2, 1880 (*price* 1 Re. 8 As.): The Nellore Portion of the Carnatic. Pt. 3, 1880 (*price* 2 Rs.): Coastal region of the Godávari District.

VOL. XVII. Royal 8vo, pp. 305. Pt. 1, 1879 (*price* 3 Rs.): Geology of Western Sind. Pt. 2, 1880 (*price* 2 Rs.): Trans-Indus extension of the Punjab Salt-range.

VOL. XVIII. Royal 8vo, pp. 300. Pt. 1, 1881 (*price* 2 Rs.): Southern Afghanistan. Pt. 2, 1881 (*price* 1 Re. 8 As.) (*out of print*): Mánbhum and Singhbhum. Pt. 3, 1881 (*price* 2 Rs.): Pránhita-Godávari Valley.

VOL. XIX. Royal 8vo, pp. 242. Pt. 1, 1882 (*price* 2 Rs.): The Cachar Earthquake of 1869. Pt. 2, 1882 (*price* 1 Re.) Thermal springs of India. Pt. 3, 1883 (*price* 1 Re.): A catalogue of Indian Earthquakes. Pt. 4, 1883 (*price* 1 Re.): Geology of parts of Manipur and the Nága Hills.

VOL. XX. Royal 8vo, pp. 240, Pt. 1, 1883 (*price* 2 Rs. 8 As.): Geology of Madura and Tinnevelly. Pt. 2, 1883 (*price* 2 Rs. 8 As.): Geological notes on the hills in the neighbourhood of the Sind and Punjab Frontier between Quetta and Dera Ghazi Khan.

VOL. XXI. Royal 8vo, pp. 286 (*out of print*). Pt. 1, 1884 (*price* 2 Rs.): Geology of the Lower Nerbudda Valley. Pt. 2, 1884 (*price* 1 Re.): Geology of Kathiawar. Pt. 3, 1885 (*price* 2 Rs.): Coal-field of South Rewah. Pt. 4, 1885 (*price* 1 Re.): Barren Island.

VOL. XXII. Royal 8vo, pp. 344, 1883. The Geology of Kashmir, Chamba, and Khagan.

VOL. XXIII. Royal 8vo, pp. 232, 1891. Geology of the Central Himálayas.

VOL. XXIV. Royal 8vo, Pt. 1, 1887 (*price* 1 Re. 8 As.): The Southern Coal-fields of the Sátpura Gondwána Basin. Pt. 2, 1890 (*price* 2 Rs. 4 As.): Physical Geology of the Sub-Himálaya of Garhwál and Kumaun. Pt. 3, 1890 (*price* 1 Re. 4 As.): Geology of South Malabar, between the Beypore and Ponnáni Rivers.

VOL. XXV. Royal 8vo, 1896. Geology of the Bellary District, Madras Presidency.

VOL. XXVI. Royal 8vo, 1896. Geology of Hazara.

VOL. XXVII. Royal 8vo. Part 1, 1895 (*price* 1 Re.): Marine Fossils from the Miocene of Upper Burma. Pt. 2, 1897 (*Price* 4 Rs.): Occurrence of Petroleum in Burma, and its technical exploitation.

VOL. XXVIII. Royal 8vo. Pt. 1, 1898 (*price* 2 Rs.): Notes on the Geological Structure of the Chitichun region. A note on the Allah-bund in the north-west of the Rann of Kuchh. Geology of parts of the Myingyan, Magwe and Pakokku Districts, Burma. The Geology of the Mikir Hills in Assam. On the Geology of Tirah and the Bazár Valley.

The price fixed for these publications is 5 Rs. (10*s*.) each volume.

Palæontologia Indica.

NEW SERIES.

VOL. I.

MEMOIRS

OF

THE GEOLOGICAL SURVEY OF INDIA.

Palæontologia Indica,

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR-GENERAL OF INDIA IN COUNCIL.

NEW SERIES.

VOL. I.

1.—THE CAMBRIAN FAUNA OF THE EASTERN SALT-RANGE.
By K. REDLICH, Ph.D.

2.—NOTES ON THE MORPHOLOGY OF THE PELECYPODA.
By FRITZ NOETLING, Ph.D., F.G.S.

3.—FAUNA OF THE MIOCENE BEDS OF BURMA.
By FRITZ NOETLING, Ph.D., F.G.S.

CALCUTTA:
SOLD AT THE
GEOLOGICAL SURVEY OFFICE.
LONDON: KEGAN PAUL, TRENCH, TRÜBNER & CO.

MDCCCCI.

PRINTED BY THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA, 8, HASTINGS STREET, CALCUTTA.

CALCUTTA:
GOVERNMENT OF INDIA CENTRAL PRINTING OFFICE,
8, HASTINGS STREET.

TABLE OF CONTENTS.

1.—THE CAMBRIAN FAUNA OF THE EASTERN SALT-RANGE
By K. Redlich, Ph.D.

2.—NOTES ON THE MORPHOLOGY OF THE PELECYPODA.
By F. Noetling, Ph.D., F.G.S.

3.—THE FAUNA OF THE MIOCENE BEDS OF BURMA.
By Fritz Noetling, Ph.D., F.G.S.

NEW SERIES.

VOL. I.

1.—THE CAMBRIAN FAUNA OF THE EASTERN SALT-RANGE.

1. THE CAMBRIAN FAUNA OF THE EASTERN SALT-RANGE.

BY

DR. KARL A. REDLICH.

INTRODUCTION.

The interesting results to which Prof. Waagen was led in his description of the fauna of the Salt-Range induced the Geological Survey of India to turn their attention to the series of beds from which that fauna was derived. Messrs. Middlemiss and Noetling accordingly set themselves the task of preparing, by investigation upon the spot, a more detailed classification of the series into zones, for at the time of the earlier geological examination of the whole Salt-Range this aim could not sufficiently be kept in view. To these two geologists therefore I owe both important geological data and accurately-made collections, on the basis of which the following palæontological work could be carried out. For the fact that this valuable and interesting material has come into my hands my thanks are due especially to my esteemed teacher, Prof. Waagen, who placed the collections of Mr. Middlemiss at my disposal; and also to Dr. Fritz Noetling, who not only supplemented this by his own collection, but also added some new forms. I am moreover deeply indebted to Dr. T. Ch. Moberg of Lund, who had the kindness to compare several specimens with the Swedish originals, and in an exhaustive correspondence has given me many data which have been of value in the right interpretation of several of the species.

LITERATURE.

1881. A. B. Wynne, Geology of the Salt-Range in the Punjab, Mem. Geol. Surv. Ind., Vol. XIV, p. 86.

1885. Waagen, Salt-Range Fossils, I, Productus-limestone fossils, Brachiopoda, p. 756, pl. 84-86.

1889. Waagen, Salt-Range Fossils, Geological Results, Pt. I. Pal. Ind., Ser. XIII, Vol. IV, pt. I.

1889. King, William, Note on the discovery of trilobites by Dr. H. Warth in the Neobolus beds of the Salt Range, Rec. Geol. Surv. Ind., Vol. XXII, p. 153-54.

1891. Waagen, Salt-Range Fossils, Geological Results, Pal. Ind., Ser. XIII, Vol. IV, pt. 2.

1891. Middlemiss, Notes on the Geology of the Salt-Range of the Punjab with a re-considered theory of the origin and age of the Salt-Marl. Rec. Geol. Surv. Ind., Vol. XXIV, p. 19.

1894. Noetling, On the Cambrian formation of the eastern Salt-Range, Rec. Geol. Surv. Ind., Vol. XXVII, p. 72-86, pl. 3.

1893. Oldham, Manual of the Geology of India, p. 100.

1896. Noetling, Beitrage zur. Kenntnis der glacialen, Schichten premischen Alters in der Salt-Range, Punjab, Neue Jahrb. 1896 Bd. II, p. 61.

PALÆONTOLOGICAL DESCRIPTION.

TRILOBITES.

HOEFERIA, nov. gen., Pl. I, Figs. 1—8*a*.

1891. *Olenellus*, sp. Waagen, Salt-Range Fossils, Pal. Ind., Ser. XIII, Geological Results, Part II, p. 105.
1894. *Olenellus*, sp. Noetling, On the Cambrian formation of the Eastern Salt-Range. Records, Geological Survey of India, Vol. XXVII, p. 76.

This form, recorded under the name of *Olenellus*, differs so greatly in various characters from the species indicated by that generic name that it is necessary to place it under a new generic designation.

The head shield is almost semicircular, slightly elevated, possesses moveable cheeks and two long cheek-spines. The glabella is cylindrical, slightly contracted towards the middle, provided on each side with four lateral furrows. The pulpebral lobes, which surround the glabella in one continuous curve, are completely separate from it and not confluent as in *Olenellus*. The facial sutures are well-developed in all the specimens and, in consequence of this, free cheeks are present.

The suture begins in the first quarter of the external margin (reckoned from the glabella), extends along the eyes, and towards the posterior margin is again directed outwards. The fixed cheeks are very narrow, whilst the free cheeks, which are provided with long cheek-spines, are almost double the width.

Of the thorax only isolated segments are preserved. The axial part is elevated; the pleuræ are grooved ("plevres a sillon" of Barrande), and end in a backwardly directed spine.

On the glabella the surface of the test shows fine backwardly directed ridges which are however so fine that they are visible only under the lens. On the thickened margin they are also present, but so much stronger that they can easily be shown in the figure. The cheeks, even when highly magnified, show nothing of the sort, but at most a fine punctation, which however is mainly due to the structure of the test.

This genus is distinguished from *Olenellus* by the presence of a well-developed facial suture and by the distinct separation of the eyes from the glabella. Walcott, indeed, describes under the name *Olenellus* a form which is closely allied to our genus but which does not show the typical characteristics of *Olenellus*. This is the *Olenellus Gilberti* which is represented on Pl. XVIII, Figs. 1 and 1 e of the "Second contribution to the studies on the Cambrian fauna of North America," Bull. U. S. Geol. Survey, 1886. In these figures we see facial sutures, although in the text it is not made clear whether they are true sutures or only fractures. Walcott indeed has informed me by letter that he has never found true facial sutures in *Olenellus*, but in the text of the work mentioned we often read of them, *e.g.*, on page 175, where he says "the course of the facial suture in front of the adult head is shown by the free cheek fig. 1 c of Pl. XVIII." The lower branch of the facial

suture indicated on the same species by the letters O X is clearly marked in our form: indeed at this place all the free cheeks are broken away. The circumstance that in the above-mentioned form we see regular lines which can only be interpreted as facial sutures, and that, at least in the figure, the eyes are perfectly quite clearly separated from the glabella, makes it probable that we have to do here with a transitional form, which approaches extraordinarily closely our Indian genus, and which already possesses facial sutures and eyes separated from the glabella, but does not yet exhibit the well-developed lower branch of the facial sutures of *Hoeferia*.

Of the genera hitherto known which can be brought into comparison with ours, *Protolenus*[1], *Paradoxides* and *Metatoxides* stand very close to it. The shape of the glabella, the presence of a complete facial suture, the free cheeks and the form of the thoracic segments agree with those of *Protolenus*. The difference consists chiefly in the absence of the ocular ridge. The eyes form a completely closed line so that with their upper and lower ends they lie directly against the glabella. This position of the eyes brings about the lengthening of the lower branch of the suture. The absence of a true occipital ring further distinguishes our species from *Protolenus*, and brings it closer to *Paradoxides*. It is also worthy of mention that in *Protolenus* the fixed cheeks are considerably increased at the cost of the free, while in *Hoeferia* the reverse is the case.

Of the allied genera *Paradoxides* and *Metatoxides* still remain, but the former is easily distinguished by its conical glabella and the latter by its short and broad head-shield, wide fixed cheeks and oblique facial suture.

HOEFERIA NOETLINGI, n. g. et. n. sp. Pl. I.

Figs. 1—8*a*.

	Var. ang.	Var. lata.
Length of head shield	19·2 mm.	18·5 mm.
Approximate breadth of head shield	36 mm.	
Length of glabella	16·5 mm.	16 mm.
Breadth of glabella	8·2 mm.	9·5 mm.

The glabella is slightly inflated, cylindrical, somewhat widened towards the posterior end, provided with four lateral furrows on each side. The first and second pair of furrows become so weak towards the middle that they are with difficulty visible; exteriorly they stretch in a forwardly directed curve. The other two unite in the middle and are bent into a similar curve. The frontal lobe is twice as broad as long, and slightly inflated. The lateral lobes, in correspondence with the furrows, are crescentic and bent forwards and outwards. The greatest

[1]G. F. Matthew, Notes on Cambrian faunas. Development of the fauna of band b. in the Cambrian division D. V I) of the St. John Group. *Canadian Record of Science, 1892.*

width of the glabella lies at the first lateral lobe. The eye-lobes, which are completely separated from the glabella, stretch without interruption in a strongly arched curve from the frontal lobe to the last lateral furrow: in form they are hook-shaped (such eye-lobes are called by Matthew "continuous"). The branch of the facial suture begins at the posterior border, runs parallel to this for a short distance, and bending outwards towards the eye passes to the anterior margin where the two sutures diverge from each other. Thus the cheeks are divided into fixed and free portions. The former are very narrow and are occupied for the most part by the eye-lobes. The free cheeks appear tolerably flat with a high marginal ridge, which forks towards the posterior margin, passing, on the one hand, round the rest of the margin and of the cheek, and on the other, outwards into a long spine. The marginal groove is deep, the limb broad and longitudinally striated. The glabella almost touches the marginal ridge so that only a small intermediate piece separates them.

Of the thorax only separated segments are known to me, in which the pleuræ bear broad grooves. They are flat and end in more or less lengthy spines. The axial rings are more arched and show a groove diminishing in depth towards the middle.

The surface structure has already been noticed in detail in the description of the genus.

Two forms can be distinguished, one with a broad and the other with a narrow glabella. The former we call var. *lata*, the latter var. *angusta*.

PTYCHOPARIA RICHTERI, n. sp. Pl. I., Figs. 21 and 22.

Although this is very badly preserved, yet the generic characters of *Ptychoparia* are recognisable in it. The conical glabella, narrowed in front, the direction of the eyes and the facial sutures, so far as they are visible, the neck-spine, and lastly the weak granulation of the test, agree in every way with the generic characters of *Ptychoparia* as constituted by Matthew[1].

The head shield is almost semicircular, the glabella narrowed in front, strongly inflated, limited by deep axial furrows, and provided on each side with three lateral furrows directed backwards, which do not reach the middle of the glabella. With the glabella is united a broad neck-segment with a long neck-spine. So far as the facial suture is visible, it begins near the genal angle and stretches along the eye, thence diverging to the anterior border, which it reaches in the first third (reckoned from the middle line of the glabella). The cheeks are slightly inflated and compressed posteriorly. The surface is weakly granulated, but the granulation is preserved only in a few places, because the specimens are for the most part casts. The neck-furrow is continued as a deep occipital groove, to which again is united a broad occipital ring.

Upon the corroded specimens the eye-sockets only are indicated. They meet the glabella at the third lateral furrow.

[1] Matthew, Illustrations of the St. John Group, No. IV, Pt. II. The small trilobite with eyes. *Proc. and Trans. Roy. Soc Canada*, Ottawa, 1888, p. 134 and 142.

The nearest ally of our form is ***Ptychoparia Linnarssoni***, Broegger, especially the variety *alata* described by Matthew.[1] The principal differences are the broad neck and occipital ring, and above all the neck spine, almost 1 cm. long. Moreover the intermediate piece which separates the glabella from the frontal margins seems to be much narrower in our form.

MOLLUSCA.

Hyolithes Eichwald.

Hyolithes Wynnei, Waagen.

1891. Waagen, Salt-Range Fossils, *Palaeont. Indica*, Ser. XIII, Vol. IV, pt. II, p. 90; Pl. I, Figs. 7—10.

I have nothing to add to the full description given by Waagen. The numerous specimens before me are derived from Middlemiss's collection, and are marked in part with "B. (lower gallery)", in part with "B 2", so that we may conclude that the form has an extensive vertical distribution.

Hyolithes sp. Pl. I., Fig. 24.

In the black shales of the *Hoeferia*-zone lie numerous remains of a species of *Hyolithes*, which is however so compressed that its original shape can only be recognised with difficulty. They are long, with apparently a triangular section. The species shows the greatest resemblance to ***Hyolithes princeps***, Billings, with which it agrees in its length and triangular section.

Mobergia, n. g.

Mobergia granulata, n. g. et. n. sp., Pl. I., Figs. 11—18.

Hoeferia Noetlingi is accompanied by a type of brachiopod which occurs in quite extraordinary abundance. All the individuals must be included in one genus and in one species, and since only one species lies before me, it is possible to unite the generic and specific descriptions.

The shell is circular or slightly elliptical and flat. The ventral valve is gently conical with a somewhat eccentrically placed umbo, which is perforated by a cleft for the passage of the foot (pedicle groove). The flattening near the umbo and at the posterior border forms a kind of false area. In the anterior are two narrow muscular scars situated close to the umbo on both sides of the foramen. They are the impressions of the hinge-muscles,— cardinal scars. Immediately below these lie a pair of wide impressions, lengthened out into a wavy line passing towards the inferior border,—the internal scars. Between these, close to one another lie the central scars which are also visible as slight depressions upon the outer surface of the shell. The dorsal valve has a marginal beak with two small lateral indentations. The

[1] Matthew, Illustrations of the St. John fauna, No. IV, l. c. p. 143, Pl. II, fig. 2.

interior shows two muscular impressions diverging towards the inferior border and between these lie close together two small central muscular scars which increase in width inferiorly.

In the interior of both valves fine radial lines pass from the point towards the inferior margin. The shell consists of several layers of phosphate of lime and chitin. It is sometimes laminated; and the uppermost layer is finely granulated, the granulation being closer around the umbo and more sparing towards the lower border, as in *Acrothele granulata*, Linn.[1] The outer side is moreover covered with close parallel striations of growth over which in many specimens lie fine radial furrows.

The closest allies of our genus are *Obolella* and *Acrothele*, and indeed one may look upon it as a transitional form between them. Of the characters of the former our new species possesses the cleft or pedicle groove for the passage of the foot and the muscle impressions of the ventral valve; of the latter the eccentric umbo, the false area, the sculpture, and the interior of the dorsal valve. The agreement goes so far that we may consider *Obolella crassa*[2] and *Acrothele granulata*[3] as the extreme forms of *Mobergia*.

Neobolus Warthi, Waagen. Pl. I. Figs. 25 a and b.

1886. Waagen, Salt-Range Fossils, I, Productus Limestone, Ser. XIII., Brachiopoda, p. 753, pl. 84, fig. 3-8.
1889. Waagen, Salt-Range Fossils, Ser. XIII, Vol. IV. Part 2. Geological Results. Pl. II, fig. 59.
1892. Hall and Clarke, An Introduction to the study of the genera of Palæozoic Brachiopoda, Part I, Natural History of New York. Palæontology. Albany, 1892 p. 84.

Neobolus Warthi is the only fossil I have been able to examine from the Neobolus zone. The ventral valve with its prominent umbo, the dorsal valve with the broad septum reaching almost to the lower border and the elliptical form agree in every respect with the species described by Waagen. The shell moreover is very thin and bluish white in colour.

Obolella sp.

In the deepest layers of the series lie the remnants of a brachiopod the generic position of which, on account of its bad preservation, it is difficult to determine. The form and structure of the shell recall the genus *Obolella*. The shell consists of several laminæ of which the lower show a longitudinal striation, while the upper are somewhat lamellar.

So far as the structure of the shell is concerned, this species most closely resembles *Obolella crassa*; but in our form the umbo appears to be more strongly incurved than in that species.

[1] Linnarson, G. Om. faunen i lagren med Paradoxides Oelandicus. *Geol. fœren. Foerhandl., Stockholm*, 1876-77, p. 352, pl. 15, fig. 12.

[2] Walcott, Second contribution to the studies on the Cambrian faunas of North America. *Bull. U. S. Geol. Surv.*, 1886, p. 114, fig. 1. (spec. 1 e. and f.).

[3] Linnarson, On the brachiopoda of the Paradoxides beds of Sweden; *Bihang R. svensk Akad. Handl.* Band 3. No. 12, 1876, p. 24, pl. IV., fig. 51. Compare also *Acrothele coriacea*, p. 21, pl. IV, fig. 44-48, Linnarson Om faunen i. lagren med Paradoxides Oelandicus l. c.

LINGULELLA WANNIECKI n. sp. Pl. I, Fig. 9 a, b, c, d.

Forms a short rounded triangle, the lower border almost horizontal; umbo broad; striations concentric, fine and regular, often also with plaits which give it a lamellar appearance.

In the interior of the shell occur two lateral scars which diverge from each other for half the length of the shell, and then approach again towards the middle depression. The latter is tolerably broad, clearly visible in the casts and widens towards the inferior border. The sculpture of the shell consists of fine radial striation and a clearly visible regularly arranged granulation. The position of the muscle impressions resembles that in *Lingulella ella* figured by Walcott[1], Fig. 4 a and b, whilst the form and radial striation are more nearly as in *Lingula attenuata*, Sow., and in the form figured by Bornemann[2] from Sicily in his Figs. 3 and 5. The chief ground for the institution of a new species lies in the invariable rounded triangular form with a horizontal inferior border, and moreover in the regular granulation, which is not known in any of the hitherto described species of *Lingulella*. *Lingulella Wanniecki* occurs in great numbers as the sole representative of this genus in the beds with *Bæferia Noetlingi*.

LINGULELLA FUCHSI, n. sp. Pl. I, fig. 10 a, b, c, d, e.

Shell a long oval, very flat. Its greatest elevation lies in the middle. The large valve is drawn out towards the point. It possesses a broad area with a cleft for the passage of the fleshy pedicle. This cleft is the chief character which distinguishes *Lingulella* from *Lingula*. Also in one individual traces are visible of a small pit in the interior of the shell such as Davidson mentions in his description of the genus. The smaller valve has two impressions placed near each other and almost reaching to the inferior border; and in the cast they leave a concave furrow. The sculpture of the shell consists of fine closely set radial lines which are cut through by longitudinal irregularly placed grooves.

This form is an equivalent of the *Lingulella* sp. which Linnarson[3] has described from the Swedish cambrian. The shape, the sculpture and the somewhat scanty evidence of the interior of the shell agree in every respect with our species. Figure 25[3] shows the two longitudinal grooves, and Figs. 27 and 28 the typical shape and also the radial and longitudinal ornamentation.

The nearest allies after this are some small forms of *Lingulella Davisii*, Salter.

Bornemann's[4] *L. attenuata*, Sow., may also be compared. Figs. 4 and 8 show a great external likeness to the Indian form. Bornemann leaves it undecided whether it is a *Lingula* or a *Lingulella*.

PSEUDOTHECA WAAGENI, n. g. et n. sp. Pl. I, Figs. 21 and 23.

1894. Stenotheca rugosa, Walc., var. aspera, Walc. Noetling, On the Cambrian formation of the Eastern Salt-Range, p. 79, Rec. Geol. Surv. of India.

[1] Walcott. Second contribution to the studies on the Cambrian faunas of North America. *Bull. U. S. Geol. Surv.*, p. 97, pl. III.

[2] Bornemann. Cambrisches Schichtensystem der Insel Sicilien. *Nova Acta Akad. Leopold.* LI. Band. p. 437, Pl. 34.

[3] Linnarson. On the brachiopoda of the Paradoxides beds of Sweden, p. 15, Pl. III, fig. 24-30.

[4] Bornemann. Cambrisches Schichtensystem der Insel Sicilien, *Nova Acta Akad. Leopold.* LI. Band. p. 437, Pl. 34.

Noetling in his account of his journey mentions this fossil as *Stenotheca rugosa*, var. *aspera*. On closer examination, however, we find that most often there are two shells belonging to each individual, and in many cases they are still united so that we must conclude that in the living state they belonged together. To what kind of animal these problematical remains belong, cannot be determined with certainty on account of the scantiness of the material. Appearances would seem to place this shell among the hingeless Lamellibranchiata, although we know no form in older Palæozic beds with so prominent and strongly curved an umbo. The greatest difficulty however in assigning this form to its proper systematic position lies in the fact that we do not even see how two such individuals are united with each other, for the rock here is of such a character that it does not unfortunately lend itself to preparation.

The single individuals consist of a pair of bent conical compressed valves. The anterior opening is therefore elliptic. The umbones are very high and enrolled, and touch one another. From the middle, deep equidistant sickle-shaped grooves, 8 to 9 in number, stretch towards the point of the shell. The union of two valves to join a pair is so characteristic that in any case we must separate this puzzling form from *Stenotheca*, although a single shell by itself completely corresponds to what we understand by that name.

CYLINDRITES, sp. Pl. I. Figs. 19 and 20.

Long cylinders, which are often arranged in a fan-shaped aggregate of various thickness. Fuchs in his work[1] "Über die Fucoiden und Hieroglyphen" has given a clear picture of the origin of these forms and has definitely removed the idea that they are the remains of algæ. To give a specific name to such worm-tracks appears to me quite superfluous, since it may well never be possible to recognise the species of annelids from which the individual tracks originate. Moreover a comparison with the genus already described is difficult, because many remain alike from the cambrian to the present day. Thus in Hall's work,[2] under the name *Palæophycus*, we see pictured cylinders which are sometimes straight and sometimes branched, and which in their disposition almost correspond to our tracks. We find a still greater likeness to *Cylindrites carespitones*, Heer, from the Muschelkalk.[3] Here we see beautifully the fan-shaped arrangement of the individual tracks. Lastly, in the Natural History Hofmuseum of Vienna there are specimens from the Flysch which are not distinguishable from ours.

I may mention here two circumstances which Fuchs notices in his concluding chapter upon the distribution of Fucoids and which are here again confirmed. That is, first, it is especially the beds which are poor in fossils that are rich in *Cylindrites*; and secondly, it is in these deposits which are formed of repeated alternations of sandstone and intervening marly beds, that the most favourable conditions for the occurrence of Hieroglyphs and Fucoids are produced.

[1] Theodor Fuchs, Studien über Fucoiden und Hieroghlyphen. *Denks. k. Akad. Wien*, 1895, p. 369.

[2] Palæontology of New York, Albany, 1847. Vol. 1. *Palaeophycus tubularis*, pl. 2, p. 7; *Palaeophycus rugosus*, pl. 21, p. 62; *Palaeophycus simplex*, pl. 22, p. 63.

[3] Heer, Flora fossilis Helvetiæ. Band. IV, pl. XXIII.

PALÆONTOLOGICAL RESULTS.

Before we proceed to a determination of the age of the beds, we must, so far as this is possible from the collections of Messrs. Middlemiss, Noetling and Waagen, fix the distribution of the individual fossils in their horizons.

The lowest zone is the Salt Marl, from which no fossils are known; and this is followed by the Khussak group or *Neobolus* beds.

I. Lower Annelid Sandstone.—A series of hard cream-coloured glauconitic sandstones alternating with thin beds of black soft sandstone. Middlemiss designates their subdivision in his section by the letter "A." They contain remnants of brachiopods belonging to the genus *Obolella*, but are not specifically determinable; and fragments of *Hyolithes*, and they are moreover full of annelid tracks. Thickness 50 feet.

II. Zone of *Hyolithes Wynnei*.—Blackish red sandstone with green spots. Contains numerous specimens of *Hyolithes Wynnei*, Waagen, and fragments of a trilobite. Here also the rock shows tracks of annelids. Thickness 10 feet.

III. Upper Annelid Sandstone.—A series of hard cream-coloured glauconitic sandstone, alternating with soft greyish black thin banded beds. This is the zone distinguished by Middlemiss as "B 2." It contains *Orthis Warthi*, Waagen, *Hyolithes Wynnei*, Waagen, and, according to Waagen, *Ptychoparia Warthi*. Noetling, however, believes that this species comes from the zone of *Hyolithes Wynnei*.

IV. Zone of *Neobolus Warthi*.—Thin red sandy micaceous beds full of *Neobolus Warthi*. This is the zone from which Prof. Waagen obtained the following nine fossils:—

Discinolepis granulata, Waagen.
Schizopolis rugosa, „
Neobolus Warthi, „
„ *Wynnei* „
Lakhmina linguloides „
„ *squama*, „
Lingula kiurensis, „
„ *Warthi*. „
Fenestella, sp. ind. „

I possess only *Neobolus Warthi* from this zone.

V. Zone of *Hoeferia Noetlingi*.—Black compact clay slates with scales of mica. They contain—

Hoeferia Noetlingi, var. *angusta*, n. sp. et n. var.
„ „ var. *lata* n. sp. et n. var.
Lingulella Wanniecki, n. sp.
Hyolithes, sp.

VI. Lower Magnesian Sandstone.—This consists in its deeper parts of sandy dolomite which contains intercalated beds of clay.

In this division are found—

> *Pseudotheca Waageni*, n. gen. et. n. sp.
> *Ptychoparia Richteri*, n. sp.

Above, the magnesian sandstone passes up into a hard clay which contains *Lingulella Fuchsi*, n. sp.

In the following beds, which Noetling calls VIII, IX, X, and moreover in the so-called Bhaganwalla group which concludes the whole complex, no fossils have hitherto been found.

Waagen, on the basis of the few fossils known to him, distinguishes the following groups in the cambrian fauna of the Salt Range (from below upwards) :—

1. Neobolus Zone.
2. Olenellus Zone.
3. Paradoxides Zone (based upon *Ptychoparia Warthi*).
4. Olenus Zone (based on *Olenus indicus*).

Unfortunately the actual spot where the individual specimens were found is in most cases unknown, and this is especially true concerning *Ptychoparia Warthi*, and the brachiopods which accompany it, and also the trilobite described as *Olenus indicus*. Thus it is clear that the zonal succession so far determined was provisional in character.

Noetling was the first who by more exact collections was able definitely to determine the order of succession, and to show that the fossils which were found with *Ptychoparia Warthi*, as well as *Olenus indicus* and the accompanying species, came from lower horizons than the *Neobolus-Olenellus* fauna. On the ground of his observations, therefore, he rectified the zonal succession and held that the beds with *Ptychoparia Warthi* and *Olenus indicus* must be considered as the lower subdivisions and that the *Neobolus* and *Olenellus* zones must follow them. At the same time he showed that the zones of *P. Warthi* and *O. indicus* would not belong to the *Paradoxides* and *Olenus* zones, because neither form is correctly placed in the genus to which it was first referred. Thus the apparent reversal of the succession in our region compared with that in other countries, was quite naturally avoided. I may, moreover, remark here that should the generic name *Ptychoparia* for *P. Warthi* prove to be correctly chosen, it will not prejudice the alteration in the succession, because *Ptychoparia* is already known to extend from the oldest to the youngest cambrian. Of the species designated as *Olenus indicus* there is too little of it preserved to allow of any definite conclusion as to the genus.

Let us consider somewhat more in detail the fossils which have since become known, and especially those of the *Hoeferia*-zone. *Hoeferia Noetlingi*, as already mentioned in the palæontological description, is very closely allied to the form figured by Walcott as *Olenellus Gilberti* (Pl. XVIII, fig. 1, 1*c*, loc. cit.) ; and its close resemblance to *Protolenus* cannot be denied, so that its relations with the fauna of the *Olenellus* zone are very close. *Mobergia* is a transitional form between *Acrothele* and *Obolella*. Although we see trilobites and brachiopods which are very

like those of the *Olenellus* zone, we must for the present give up the idea of an exact determination of the age of this zone, because both the species of the *Hoeferia*-zone belong to genera which are not found elsewhere.

Only this much can be said that the relationships of *Hoeferia* and *Mobergia* point chiefly to the lower cambrian, and at the highest to the middle cambrian, so that probably we have to do with an old cambrian fauna. The deposits found below these beds, however, do not offer any data whatever for determining their horizon, because their fossils are for the most part new genera in indifferent forms such as *Ptychoparia Warthi,* which may belong as well to the *Olenellus* zone as to the following *Paradoxides* or *Olenus* zones.

Even if the *Hoeferia*-zone is lower cambrian, we cannot yet consider that the underlying beds are necessarily older than all the cambrian deposits hitherto known, for they may possibly belong in their entirety to the lower parts of the *Olenellus* zone of other lands.

The beds with *Hoeferia Noetlingi* are followed by the Magnesian Sandstone group, from which we have described a *Ptychoparia* and several *Lingulellas*. *Ptychoparia Richteri* has a great resemblance to *P. Linnarsoni*. *Lingulella Fuchsi*, although not identical with it, is yet very closely allied to a species of *Lingulella* which Linnarsson has described from the *Paradoxides* beds of Sweden. Here again we find the remnants too scanty to admit of a direct comparison with the *Paradoxides* beds of other countries.

Lastly this group is succeeded by the Bhaganwalla group or Salt Crystal Pseudomorph group, the close connection of which with the Magnesian Sandstone leaves no doubt, as Noetling says [1] as to its inclusion in the cambrian.

The result of our researches on the relations of the fauna may be shortly summed up by saying that we now know of a cambrian fauna in the Salt Range which according to the fossils known from it cannot be referred to a later horizon than the *Paradoxides* zone.

The composition of the fauna is very simple. In spite of the extraordinary abundance of individuals there are only a few genera and species. In the lowest beds are found the remnants of a single brachiopod. The same poverty of species is met with in the higher zones, for they are distinguished by only two brachiopods and one *Hyolithes*. It is in the *Neobolus Warthi* zone for the first time that a great differentiation of species is to be noticed, and this, again, becomes less marked in the *Noetlingi* fauna, where in spite of the abundance of trilobites and brachiopods, only a single species of the one order and two of the other can be distinguished. Here in fact this peculiarity is at its height. It points to a great depth of the ocean, and this view is supported by the sudden change of lithological character. Up to this point we have seen sandstones with numberless grains of glauconite, while here suddenly black clay slates without any trace of glauconite come in. It is therefore remarkable that despite these indications calcium sulphate and chloride are discovered in this complex, for usually they point only to a moderate depth.

[1] The Cambrian formation of the eastern Salt Range, l. c., p. 81. Beiträge zur Kenntnis der glacialen Schichten permischen Alters in der Salt-Range l. c., p. 67.

THE RELATIONS OF THE CAMBRIAN TO THE OVERLYING CARBONIFEROUS BEDS.

Turning our attention now to the overlying beds we find that the cambrian beds are succeeded unconformably by rocks of upper carboniferous age. The unconformity has been noticed by Waagen[1] in these words :—

"This group appears to rest everywhere discordant on the lower beds, and thus comes in contact locally with all the groups from No. 2 to No. 7. However, in the single sections, this discordance can be observed only with difficulty, and thus Mr. Wynne was led to infer the absence of any decided discordance within the entire series of rock-groups in the Salt Range. With regard to a discordance between the red shaly zone and the group here under description I myself am by no means certain, though I accept it in the very positive assertions of the circumstance by Dr. King and Mr. R. Oldham, whilst I myself have seen the boundary between two groups only at a few places." Oldham[1a] believed, on the other hand, that the unconformably overlying beds were not upper carboniferous. He compared them with upper cretaceous beds and held the fauna found in them to be derived from far older upper carboniferous deposits. At a later date it was shown[2] that the beds in question really belonged to the upper carboniferous period.

This carboniferous overlap has been still more clearly affirmed by Noetling[3] and Middlemiss.[4] In the chain of the Himálayas, on the other hand, the succession is complete and the silurian and devonian beds are intercalated.

Similar conditions are met with in China. In Northern China Richthofen found an overlap of the carboniferous rocks upon the cambrian,[5] while in the southern part, in the folded mountain chains and in Southern Shansi and Kansu, the silurian and devonian come in. In other parts of the world also there is often a gap between the carboniferous and the cambrian beds.

Concerning the area between the Great Basin and the Rocky Mountains of Colorado and New Mexico Dutton writes:[6] "Within the province the very few exposures now known present the carboniferous strata resting either upon the cambrian or upon the archæan. The devonian and silurian are either wholly absent or are represented by a few eroded remnants of trifling extent."

Newton and Tenney[7] report their occurrence in the Black Hills and describe how the cambrian Potsdam Sandstone lies directly upon the folded archæan and metamorphic rocks, and is itself overlaid by the carboniferous beds.—"Whenever the Potsdam Sandstone and the lower carboniferous series are together visible, they are

[1] Waagen, Salt-Range Fossils. Vol. IV, pt. I. Geological Results, p. 40 and fig. 6 p. 43.

[1a] Oldham, Rec. Geol. Surv. India, Vol. XIX. (1886), p. 129.

[2] Oldham, Geology of India. 1893, p. 121.

[3] Noetling. Beitraege zur Kenntnis der glacialen Schichten permischen Alters in der Salt Range. p. 79, l. c.

[4] Middlemiss, Notes on the geology of the Salt-Range of the Punjab. etc., Rec. G. S. I. Vol. xxiv., p. 19.

[5] Richthofen, China. II Band. p. 646, and numerous sections in Liantung, p. 94, fig. 21.

[6] E. Dutton, Mount Tayler and the Zuni Plateau. Sixth Ann. Rep. U. S. Geol. Surv. 1884-85. p. 153.

[7] H Newton and W. T. Tenney, Report on the Geology and Resources of the Black Hills of Dakota. Washington, 1880, p. 109. A series of sections explains the relations of the Carboniferous to the Cambrian. cf. p. 86 and 87.

absolutely conformable and the distinction between the rocks of the two systems is often so perfectly marked, that the blade of a penknife may be inserted at their line of separation."

The discordance is also known in the northern part of Texas,[1] while in the southern part silurian and devonian beds are present, just as in the folded border mountains east and west of the Rocky Mountains and the Appalachians.

In the Rocky Mountains and the Plateau region just as in the prairies of Texas, etc., the carboniferous rocks overlap the older beds and almost always rest upon rocks of the cambrian age, while in the folded Basin Ranges on the one side and the Appalachians in the other the palæozoic series is complete and concordant.

In all these cases there appears to be a certain analogy with the relations of the Salt-Range to the Himálayas. It is indeed insufficient to form the basis for further conclusions; but it is nevertheless of importance in that the palæozoic series of the Salt-Range differs so much in its incompleteness from that of the neighbouring folded region of the Himálayas, and recalls in several respects that of the Peninsula.

[1] Second Annual Report of the Geol. Survey of Texas, 1890, p. 290.

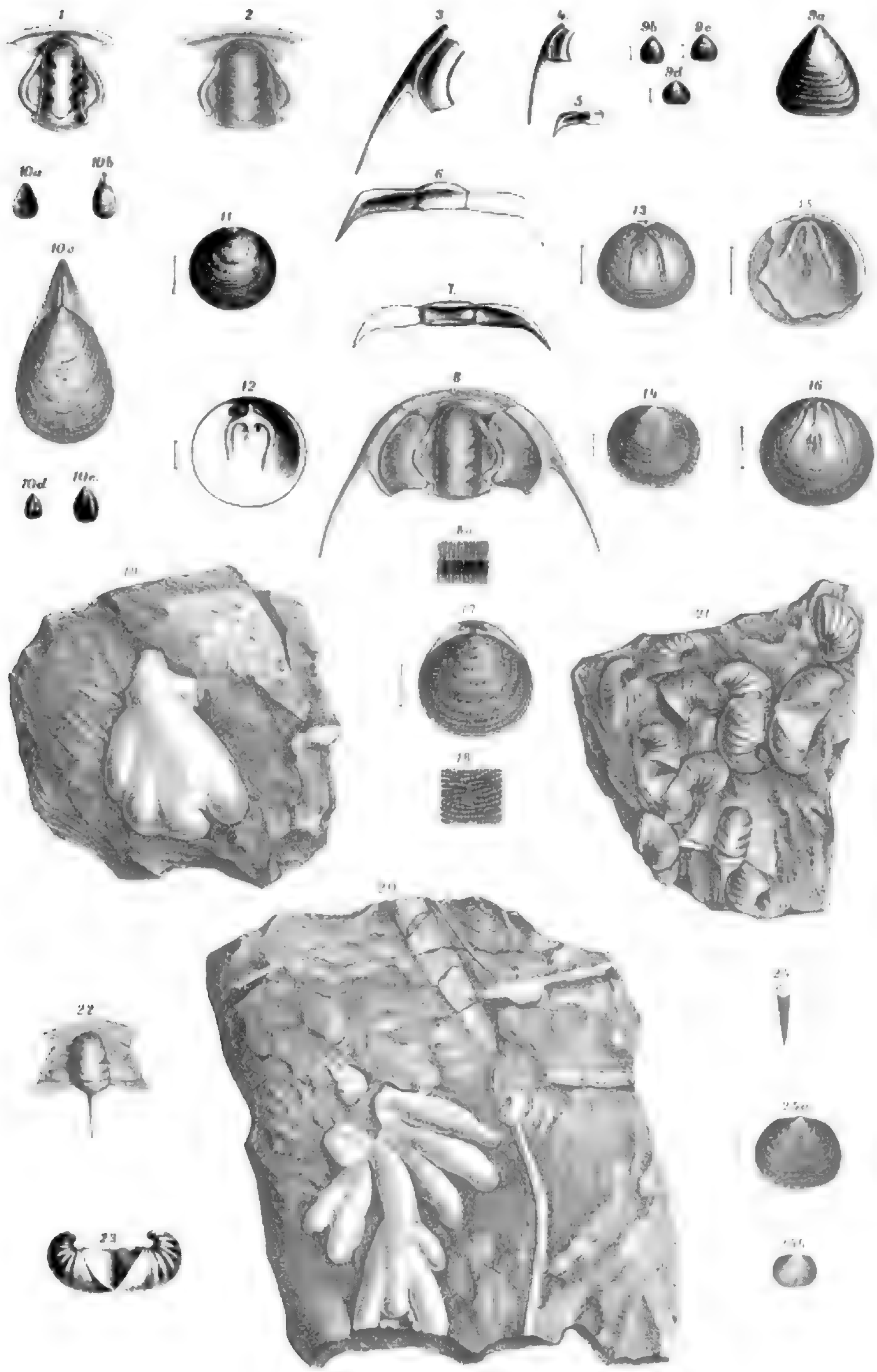
PLATE I.

Fig.	1.	Hoeferia Noetlingi, n. g. et n. sp. var. angusta.
„	2.	„ „ „ „ var. lata.
„	3.	„ „ Free cheeks.
„	5—7.	„ „ Thoracic segments.
„	8.	„ „ var. angusta. Restored.
„	8a.	„ „ Surface of the glabella.
„	9a-d.	Lingulella Wanniecki, n. sp. (9a enlarged 7 times.)
„	10a, b, c.	Lingulella Fuchsi, n. sp.—10c. enlarged 4½ times, area with cleft for passage of foot.
„	11.	Mobergia granulata, n. g. et n. sp. Exterior of Ventral valve.
„	12.	„ „ Interior of Ventral valve.
„	13.	„ „ Cast of Ventral valve.
„	14.	„ „ Exterior of Dorsal valve.
„	15.	„ „ Interior of Dorsal valve.
„	16.	„ „ Cast of Dorsal valve.
„	17.	Mobergia granulata, showing the valves.
„	18.	„ „ Fragmant of shell, enlarged 10 times.
„	19 and 20.	Cylindrites, sp.
„	21.	Fragment with Pseudotheca Waageni, n. g. et n. sp., and Ptychoparia Richteri, n. sp.
„	22.	Ptychoparia Richteri, n. sp.
„	23.	Pseudotheca Waageni, n. g. et n. sp.
„	24.	Hyolithes, sp.
„	25.	Neobolus Warthi, Waagen ; (a) Ventral valve, (b) Dorsal valve.

GEOLOGICAL SURVEY OF INDIA.

Dr. K. Redlich

Palæontologia Indica Vol. I. Pl. I.



RECORDS OF THE GEOLOGICAL SURVEY OF INDIA.

VOLS. I TO XXX, 1868 TO 1897.

The price fixed for these publications is 1 rupee (2s.) each part, or 2 rupees (4s.) each volume.

NOTE—*The Records ceased to be published from the 1st January 1898.*

MISCELLANEOUS PUBLICATIONS.

A Manual of the Geology of India. 4 Vols. With map. 1879-1887—

Vol. 1. Peninsular Area.
Vol. 2. Extra-Peninsular Area. } By H. B. Medlicott and W. T. Blanford. Price 8 rupees (*out of print*).
Vol. 3. Economic Geology. By V. Ball. Price 5 rupees (*out of print*).
Vol. 4. Mineralogy. By F. R. Mallet. Price 2 rupees.

A Manual of the Geology of India, 2nd edition. By R. D. Oldham. (1893). Price 8 rupees.

A Manual of the Geology of India, Economic Geology, by the late Prof. V. Ball, 2nd edition, revised in parts.
Part I.—Corundum. By T. H. Holland (1898). Price 1 rupee.

Popular guides to the geological collections in the Indian Museum, Calcutta—
No. 1. Tertiary vertebrate animals. By R. Lydekker. 1879. Price 2 annas (*out of print*).
No. 2. Minerals. By F. R. Mallet. (1879.) Price 2 annas (*out of print*).
No. 3. Meteorites. By F. Fedden. (1880.) Price 2 annas.
No. 4. Palæontological collections. By O. Feistmantel. (1881.) Price 2 annas.
No. 5. Economic mineral products. By F. R. Mallet. (1883.) Price 2 annas (*out of print*).

Descriptive catalogue of the collection of Minerals in the Geological Museum, Calcutta. By F. R. Mallet. (1883.) Price 2 rupees.

An Introduction to the Chemical and Physical study of Indian Minerals. By T. H. Holland. (1895.) Price 8 annas.

Catalogue of the remains of Siwalik Vertebrata contained in the Geological Department of the Indian Museum. By R. Lydekker, Pt. I. Mammalia. (1885.) Price 1 rupee. Pt. II. Aves, Reptilia, and Pisces. (1886.) Price 4 annas.

Catalogue of the remains of Pleistocene and Pre-Historic Vertebrata contained in the Geological Department of the Indian Museum. By R. Lydekker. (1886.) Price 4 annas.

Bibliography of Indian Geology. By R. D. Oldham. (1888.) Price 1 rupee 8 annas.

Report on the Geological Structure and Stability of the hill slopes around Naini Tal. By T. H. Holland. (1897.) Price 3 rupees.

Report on the Inspection of Mines in India, for the year ending 30th June 1894. By James Grundy. (1894.) Price 1 rupee.

Report on the Inspection of Mines in India for the year ending 30th June 1895. By James Grundy. (1896.) Price 2 rupees.

Report on the Inspection of Mines in India for the year ending 30th June 1896. By James Grundy. (1897.) Price 1 rupee.

Report on the Inspection of Mines in India for the year ending 31st December 1896. By James Grundy. (1897.) Price 1 rupee.

Report on the Inspection of Mines in India for the year ending 31st December 1897. By James Grundy. (1898.) Price 1 rupee 8 annas.

Report on the Inspection of Mines in India for the year ending 31st December 1898. By James Grundy. (1899.) Price 12 annas.

Geological map of India, 1893. Scale 1″ = 96 miles. Price 1 rupee.

To be had on application to the Registrar, Geological Survey of India, Calcutta. ; London : Kegan Paul, Trench, Trübner & Co.

PALÆONTOLOGIA INDICA.

(Series I, III, V, VI, VIII.)
CRETACEOUS FAUNA OF SOUTHERN INDIA, *by* F. STOLICZKA, *except* Vol. I, Pt. 1, *by* H. F. BLANFORD.

Vol. I. The Cephalopoda (1861—65), pp. 216, pls. 94 (6 double).
" II. The Gastropoda (1867—68), pp. xiii, 500, pls. 28.
" III. The Pelecypoda (1870—71), pp. xxii, 537, pls. 50.
" IV. The Brachiopoda, Ciliopoda, Echinodermata, Corals, etc. (1872—73), pp. v, 202, pls. 29.

(Series II, XI, XII.)
THE FOSSIL FLORA OF THE GONDWANA SYSTEM, *by* O. FEISTMANTEL, *except* Vol. I, Pt. 1, *by* T. OLDHAM *and* J. MORRIS.

Vol. I, pp. xviii, 233, pls. 72. 1863—79. Pt. 1; Rájmahál Group, Rájmahál Hills. Pt. 2; *The same (continued)*. Pt. 3; Plants from Golapilli. Pt. 4; Outliers on the Madras Coast.
" II, pp. xli, 115, pls. 26. 1876—78. Pt. 1; Jurassic Flora of Kach. Pt. 2; Flora of the Jabalpur Group.
" III, pp. xi, 64 + 149, pls. 80 (9 double) (I—XXXI + IA—XLVIIA). 1879—81. Pt. 1; The Flora of the Talchir-Karharbari beds. Pt. 2; The Flora of the Damuda and Panchet Divisions. Pt. 3; *The same (concluded)*.
" IV, pp. xxvi, 25 + 66, pls. 35 (2 double) (I—XXV + IA—XIVA). Pt. 1 (1882), Fossil Flora of the South Rewah Gondwana basin. Pt. 2 (1886); Fossil Flora of some of the Coal-fields in Western Bengal.

(Series IX.)
JURASSIC FAUNA OF KACH.

Vol. I (1873—76). The Cephalopoda, by W. Waagen, pp. i, 247, pls. 60 (6 double).
" II, pt. 1 (1893). The Echinoidea of Kach, by J. W. Gregory, pp. 12, pls. 2.

(Series IV.)
INDIAN PRE-TERTIARY VERTEBRATA.

Vol. I, pp. vi, 137, pls. 26. 1865—85. Pt. 1 (1865); The Vertebrate Fossils from the Panchet rocks, by T. H. Huxley. Pt. 2 (1878); The Vertebrate Fossils of the Kota-Maleri Group, by Sir P. de M. Grey Egerton and L. C. Miall. Pt. 3 (1879); Reptilia and Batrachia, by R. Lydekker. Pt. 4 (1885): The Labyrinthodont from the Bijori Group, by R. Lydekker. Pt. 5 (1885); The Reptilia and Amphibia of the Maleri and Denwa groups, by R. Lydekker.

(Series X.)
INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA, *by* R. LYDEKKER, *except* Vol. I, Pt. 1, *by* R. B. FOOTE.

Vol. I, pp. xxx, 300, pls. 50. 1874—80. Pt. 1; Rhinoceros deccanensis. Pt. 2; Molar teeth and other remains of Mammalia. Pt. 3; Crania of Ruminants. Pt. 4; Supplement to Pt. 3. Pt. 5; Siwalik and Narbada Proboscidia.
" II, pp. xv, 363, pls. 45. 1881—84. Pt. 1; Siwalik Rhinocerotidæ. Pt. 2; Supplement to Siwalik and Narbada Proboscidia. Pt. 3; Siwalik and Narbada Equidæ. Pt. 4; Siwalik Camelopardalidæ. Pt. 5; Siwalik Selenodont Suina, etc. Pt. 6; Siwalik and Narbada Carnivora.
" III, pp. xxiv, 264, pls. 38. 1884—86. Pt. 1; Additional Siwalik Perissodactyla and Proboscidia. Pt. 2; Siwalik and Narbada Bunodont Suina. Pt. 3; Rodents and new Ruminants from the Siwaliks. Pt. 4; Siwalik Birds. Pt. 5; Mastodon Teeth from Perim Island. Pt. 6; Siwalik and Narbada Chelonia. Pt. 7; Siwalik Crocodilia, Lacertilia and Ophidia. Pt. 8; Tertiary Fishes.
" IV, Pt. 1, 1886. Siwalik Mammalia (Supplement 1), pp. 18, pls. 6.
" " Pt. 2, 1886. The Fauna of the Karnul caves (and addendum to Pt. 1); pp. 40 (19—58), pls. 5 (vii—xi).
" " Pt. 3, 1887. Eocene Chelonia from the Salt Range; pp. 7 (59—65), pls. 2 (xii—xiii).

(Series XIII.)
SALT-RANGE FOSSILS, *by* WILLIAM WAAGEN, Ph.D.

Productus-Limestone Group: Vol. I, pt. 1 (1879). Pisces, Cephalopoda, pp. 72, pls. 6.
" " " 2 (1880). Gastropoda and Supplement to pt. 1, pp. 111 (73—183), pls. 10 (1 double), (vii—xvi).
" " " 3 (1881). Pelecypoda, pp. 144 (185—328), pls. 8 (xvii—xxiv).
" " " 4 (1882—85). Brachiopoda, pp. 442 (329—770), pls. 62 (xxv—lxxxvi).
" " " 5 (1885). Bryozoa—Annelidæ—Echinodermata, pp. 64 (771—834), pls. 10 (lxxxvii—xcvi).
" " " 6 (1886). Cœlenterata, pp. 90 (835—924), pls. 20 (xcvii—cxvi).
" " " 7 (1887). Cœlenterata, Protozoa, pp. 74 (925—998), pls. 12 (cxvii—cxxviii).
Fossils from the Ceratite Formation: Vol. II, pt. 1 (1895). Pisces—Ammonoidea, pp. 324, pls. 40.
Geological Results: Vol. IV, pt. 1 (1889), pp. 1—88, pls. 4.
" " " " 2 (1891), pp. 89—242, pls. 8.

(Series VII, XIV.)
TERTIARY AND UPPER CRETACEOUS FAUNA OF WESTERN INDIA, *by* P. MARTIN DUNCAN *and* W. PERCY SLADEN, *except* Pt. 1, *by* F. STOLICZKA.

Vol. I, pp. 16 + 110 + 383 + 91 = 600, pls. 5 + 28 + 58 + 13 = 104. 1871—86. Pt. 1; Tertiary Crabs from Sind and Kach. Pt. 1 (new 2); Sind Fossil Corals and Alcyonaria. Pt. 3; The Fossil Echinoidea of Sind: *Fas. 1*, The *Cardita beaumonti* beds; *Fas. 2*, The Ranikot series in Western Sind; *Fas. 3*, The Kirthar Series; *Fas. 4*, The Nari (Oligocene) Series; *Fas. 5*, The Gaj (Miocene) Series; *Fas. 6*, The Makrán (Pliocene) Series. Pt. 4; The Fossil Echinoidea of Kach and Kattywar.

(Series XV.)
HIMALAYAN FOSSILS, *by* CARL DIENER, Ph.D.

The Permocarboniferous Fauna of Chitichun No. I: Vol. I. pt. 3 (1897), pp. 105, pls. 13
The Permian Fossils of the Productus Shales of Kumaon and Gurhwal: Vol. I, pt. 4 (1897), pp. 54, pls. 5.
The Cephalopoda of the Lower Trias: Vol. II, pt. 1 (1897), pp. 182, pls. 23.
The Cephalopoda of the Muschelkalk: Vol. II, pt. 2 (1895). Trias, pp. 118, pls. 31.

(Series XVI.)
BALUCHISTAN FOSSILS, *by* FRITZ NOETLING, Ph.D., F.G.S.

The Fauna of the Kellaways of Mazár Drik: Vol. I, pt. 1 (1895), pp. 22, pls. 13.
The Fauna of the (Neocomian) Belemnite Beds: Vol. I, pt. 2 (1897), pp. 5, pls. 2.
The Fauna of the Upper Cretaceous (Maëstrichtien) Beds of the Mari Hills: Vol. I, pt. 3 (1897), pp. 79, pls. 23.

The price fixed for these publications is 4 annas (6 pence) per single plate.

To be had at the Geological Survey Office, Calcutta.—London: Kegan Paul, Trench, Trübner & Co.

MEMOIRS

OF

THE GEOLOGICAL SURVEY OF INDIA.

Palæontologia Indica,

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

New Series.

VOL. I.

2.—NOTES ON THE MORPHOLOGY OF THE PELECYPODA.

By FRITZ NOETLING, Ph.D., F.G.S.,
PALÆONTOLOGIST, GEOLOGICAL SURVEY OF INDIA

PLATES II TO V.

CALCUTTA:
SOLD AT THE
GEOLOGICAL SURVEY OFFICE;
LONDON: KEGAN PAUL, TRENCH, TRÜBNER & CO.

MDCCCXCIX.

PRINTED BY THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA, 8, HASTINGS STREET, CALCUTTA.

MEMOIRS OF THE GEOLOGICAL SURVEY OF INDIA.

VOL. I. Royal 8vo, pp. 309, 1859 (*out of print*). Pt. 1, 1856 (*price* 1 Re.): Preliminary notice on the Coal and Iron of Talchir.—On the geological structure and relations of the Talchir Coal-field.—Gold-yielding deposits of Upper Assam.—On specimens of gold and gold dust from Shué-gween. Pt. 2, 1858 (*price* 2 Rs.): On the geological structure of a portion of the Khasi Hills.—On the geological structure of the Nilghiri Hills (Madras). Pt. 3, 1859 (*price* 2 Rs.): On the geological structure and physical features of the Districts of Bankura, Midnapore, and Orissa.—On the laterite of Orissa.—On some fossil fish-teeth of the genus Ceratodus, from Maledi, south of Nagpur.

VOL. II. Royal 8vo, pp. 341, 1859 (*out of print*). Pt. 1, 1860 (*price* 2 Rs.): On the Vindhyan Rocks, and their associates in Bundelkand. Pt. 2, 1860 (*price* 3 Rs.): On the geological structure of the central portion of the Nerbudda District.—On the tertiary and alluvial deposits of the central portion of the Nerbudda Valley.—On the geological relations and probable geological age of the several systems of rocks in Central India and Bengal.

VOL. III. Royal 8vo, pp. 438. Pt. 1, 1863 (*price* 3 Rs.) (*out of print*). On the geological structure and relations of the Raniganj Coal-field.—Additional Remarks on the geological relations and probable geological age of the several systems of rocks in Central India and Bengal.—Indian Mineral Statistics, I. Coal. Pt. 2, 1864 (*price* 2 Rs.): On the Sub-Himálayas Ranges between the Ganges and Ravi.

VOL. IV. Royal 8vo, pp. 450. Pt. 1, 1863 (*price* 2 Rs.): Report on the Cretaceous Rocks of Trichinopoly District, Madras. Pt. 2, 1864 (*price* 2 Rs.): (*out of print*). On the structure of the Districts of Trichinopoly, Salem, etc. Pt. 3, 1865 (*price* 1 Re.): On the Coal of Assam, etc.

VOL. V. Royal 8vo, pp. 354. Pt. 1, 1865 (*price* 3 Rs.) (*out of print*). Sections across N.-W. Himálaya, from Sutlej to Indus.—On the Gypsum of Spiti. Pt. 2, 1866 (*price* 1 Re.): On the Geology of Bombay. Pt. 3, 1866 (*price* 1 Re.) (*out of print*). On the Jherria Coal-field.—Geological Observations on Western Tibet.

VOL. VI. Royal 8vo, pp. 395. Pt. 1, 1867 (*price* 8 As.): On the Neighbourhood of Lynyan, etc., in Sind.—Geology of a Portion of Cutch. Pt. 2, 1867 (*price* 2 Rs.) (*out of print*): Bokáro Coal-field.—Rámgarh Coal-field.—Traps of Western and Central India. Pt. 3, 1869 (*price* 2 Rs. 8 As.) Tapti and Nerbudda Valleys.—Frog-beds in Bombay.—*Oxyglossus pusillus.*

VOL. VII. Royal 8vo, pp. 342. Pt. 1, 1869 (*price* 3 Rs.): Vindhyan Series.—Mineral Statistics.—Coal.—Shillong Plateau. Pt. 2, 1870 (*price* 1 Re.): Karharbári Coal-field.—Deoghar Coal-field. Pt. 3, 1871 (*price* 1 Re.): Aden Water-supply.—Káranpura Coal-fields.

VOL. VIII. Royal 8vo, pp. 353. Pt. 1, 1872 (*price* 4 Rs.): On the Kadapah and Karnul Formations in the Madras Presidency. Pt. 2, 1872 (*price* 1 Re.): Itkhuri Coal-field.—Daltonganj Coal-field.—Chope Coal-field.

VOL. IX. Royal 8vo, pp. iv, 358. Pt. 1, 1872 (*price* 4 Rs.): Geology of Kutch. Pt. 2, 1872 (*price* 1 Re.): Geology of Nagpúr.—Geology of Sirban Hill.—Carboniferous Ammonites, pp. 65.

VOL. X. Royal 8vo, pp. 359. Pt. 1 (*price* 3 Rs.): Geology of Madras.—Sátpura Coal-basin. Pt. 2, 1874 (*price* 2 Rs.): Geology of Pegu.

VOL. XI. Royal 8vo, pp. 338. Pt. 1, 1874 (*price* 2 Rs.): Geology of Dárjiling and Western Duars. Pt. 2, 1876 (*price* 3 Rs.): Salt-region of Kohát, Trans-Indus.

VOL. XII. Royal 8vo, pp. 363. Pt. 1, 1877 (*price* 3 Rs.): South Mahrátta Country. Pt. 2, 1876 (*price* 2 Rs.): Coal-fields of the Nága Hills.

VOL. XIII. Royal 8vo, pp. 248. Pt. 1, 1877 (*price* 2 Rs. 8 As.): Wardha Valley Coal-field. Pt. 2, 1877 (*price* 2 Rs. 8 As.): Geology of the Rájmahál Hills.

VOL. XIV. Royal 8vo, pp. 313, 1878. Geology of the Salt-range in the Punjab.

VOL. XV. Royal 8vo, pp. 192. Pt. 1, 1878 (*price* 2 Rs. 8 As.): Geology of the Aurunga and Hutár Coal-fields (Palamow). Pt. 2, 1880 (*price* 2 Rs. 8 As.): Ramkola and Tatapani Coal-fields (Sirguja).

VOL. XVI. Royal 8vo, pp. 264. Pt. 1, 1879 (*price* 1 Re. 8 As.): Geology of Eastern Coast from Lat. 15° to Masulipatam. Pt. 2, 1880 (*price* 1 Re. 8 As.): The Nellore Portion of the Carnatic. Pt. 3, 1880 (*price* 2 Rs.): Coastal region of the Godávari District.

VOL. XVII. Royal 8vo, pp. 305. Pt. 1, 1879 (*price* 3 Rs.): Geology of Western Sind. Pt. 2, 1880 (*price* 2 Rs.): Trans-Indus extension of the Punjab Salt-range.

VOL. XVIII. Royal 8vo, pp. 300. Pt. 1, 1881 (*price* 2 Rs.): Southern Afghanistan. Pt. 2, 1881 (*price* 1 Re. 8 As.) (*out of print*): Mánbhum and Singhbhum. Pt. 3, 1881 (*price* 2 Rs.): Pránhita-Godávari Valley.

VOL. XIX. Royal 8vo, pp. 242. Pt. 1, 1882 (*price* 2 Rs.): The Cachar Earthquake of 1869. Pt. 2, 1882 (*price* 1 Re.) Thermal springs of India. Pt. 3, 1883 (*price* 1 Re.): A catalogue of Indian Earthquakes. Pt. 4, 1883 (*price* 1 Re.): Geology of parts of Manipur and the Nága Hills.

VOL. XX. Royal 8vo, pp. 240, Pt. 1, 1883 (*price* 2 Rs. 8 As.): Geology of Madura and Tinnevelly. Pt. 2, 1883 (*price* 2 Rs. 8 As.): Geological notes on the hills in the neighbourhood of the Sind and Punjab Frontier between Quetta and Dera Ghazi Khan.

VOL. XXI. Royal 8vo, pp. 286 (*out of print*). Pt. 1, 1884 (*price* 2 Rs.): Geology of the Lower Nerbudda Valley. Pt. 2, 1884 (*price* 1 Re.): Geology of Kathiawar. Pt. 3, 1885 (*price* 2 Rs.): Coal-field of South Rewah. Pt. 4, 1885 (*price* 1 Re.): Barren Island.

VOL. XXII. Royal 8vo, pp. 344, 1883. The Geology of Kashmir, Chamba, and Khagan.

VOL. XXIII. Royal 8vo, pp. 232, 1891. Geology of the Central Himálayas.

VOL. XXIV. Royal 8vo, Pt. 1, 1887 (*price* 1 Re. 8 As.): The Southern Coal-fields of the Sátpura Gondwána Basin. Pt. 2, 1890 (*price* 2 Rs. 4 As.): Physical Geology of the Sub-Himálaya of Garhwál and Kumaun. Pt. 3, 1890 (*price* 1 Re. 4 As.): Geology of South Malabar, between the Beypore and Ponnáni Rivers.

VOL. XXV. Royal 8vo, 1895. Geology of the Bellary District, Madras Presidency.

VOL. XXVI. Royal 8vo, 1896. Geology of Hazara.

VOL. XXVII. Royal 8vo. Part 1, 1895 (*price* 1 Re.): Marine Fossils from the Miocene of Upper Burma. Pt. 2, 1897 (*Price* 4 Rs.): Occurrence of Petroleum in Burma, and its technical exploitation.

VOL. XXVIII. Royal 8vo. Pt. 1, 1898 (*price* 2 Rs.): Notes on the Geological Structure of the Chitichun region. A note on the Allah-bund in the north-west of the Rann of Kuchh. Geology of parts of the Myingyan, Magwe and Pakokku Districts, Burma. The Geology of the Mikir Hills in Assam. On the Geology of Tirah and the Bazár Valley.

The price fixed for these publications is 5 Rs. (10*s.*) each volume.

NEW SERIES.

VOL. I.

2.—NOTES ON THE MORPHOLOGY OF THE PELECYPODA.

2. NOTES ON THE MORPHOLOGY OF THE PELECYPODA.

1.—THE HINGE OF SOME MIOCENE AND RECENT BIVALVES.

BY

FRITZ NOETLING, PH.D., F.G.S.,

PALÆONTOLOGIST, GEOLOGICAL SURVEY OF INDIA.

I.—GENERAL PART.

To any student of Pelecypoda the obvious neglect of the hinge of the Pelecypoda from a morphological point of view must appear rather striking. The great systematic importance of the hinge of the Pelecypoda has been denied by nobody, yet it may seem strange that up to quite recently the homologies of the different teeth constituting the hinge of the Pelecypoda have been entirely neglected.

Everybody seems to have been satisfied with the time-honoured division of cardinal and lateral teeth, which appeared to answer all requirements, but there is hardly a manual in which, for instance, the distinguishing character of cardinals and posterior laterals is clearly set forth. Anybody going through the description of a bivalve hinge in some older palæontological works will, however, be struck with the unsatisfactory, not to say insufficient, way the distinction is carried out. Even in some of the most recent hand-books like that of Zittel, we find, for instance, the hinge of *Crassatella* described as follows: "Cardinal teeth 2 : 2; a weak posterior and sometimes also an anterior lateral in the right valve", and if we turn a few pages over we find the hinge of *Fimbria* described as follows: "Cardinal teeth 2 : 2; short, unequal, besides an anterior and posterior lateral tooth". It would be very difficult to discover the difference of the hinge of *Crassatella* and *Fimbria* from such a diagnosis, though nobody will deny how widely different the two are.

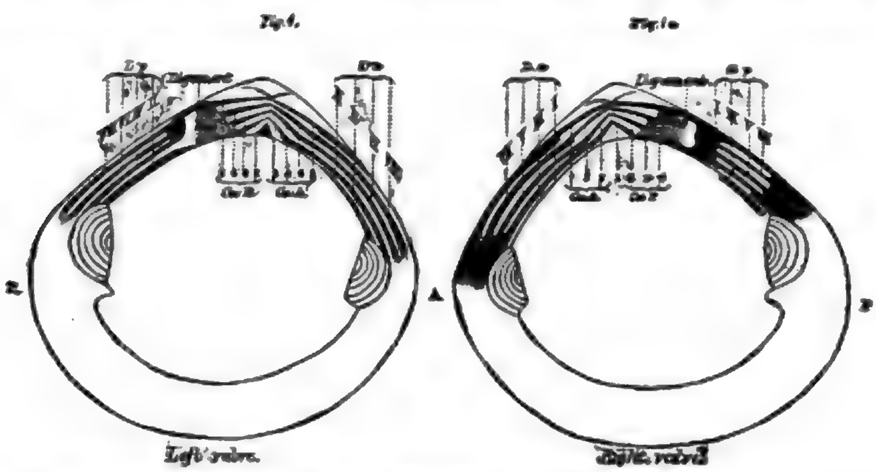
Even Neumayr, who in several papers dealt so minutely with the hinge of the bivalves and who based his system of the Pelecypoda chiefly on the hinge, overlooked the serious drawback in the description of the hinge, which consisted in the want of an exact terminology based on the homologies of the teeth; only on the base of such a terminology an accurate description can be given.

It is only quite lately that Palæontologists have recognised the value of such a terminology, and thanks to the diligent researches of Professor Munier-Chalmas and Professor Bernard, the terminology of the hinge of the Pelecypoda has been brought to such a perfection that hardly anything remains to be added. The enormous advantage of such a perfect terminology is obvious, and there can be no doubts now

as to the homology of the teeth in the hinge of bivalves, if the system as suggested by Messrs. Munier-Chalmas and Bernard is adopted. As both differ however in some points, it will be well to explain in detail the system suggested by each of these authors.

Munier-Chalmas has laid down his ingenious system in two short notes,[1] but has not, at least as far as I know, published any other communications on the subject; in Stefanescu's paper[2] however further notes will be found, and the following will demonstrate his system.

Munier-Chalmas is of the opinion that the typical hinge of the Heterodontes is composed of six primary anterior, and six primary posterior lamellæ; those of the right valve interlocking with those of the left; he seems, however, to have altered his views with regard to the number of the lamellæ, and supposes eight to be the correct number, but on what grounds he arrived at this conclusion I am unable to say. Now if we design by I, III, V, VII (odd numbers) the primary lamellæ of the right valve, and by II, IV, VI, VIII (even numbers) those of the left valve, the order of succession in the closed valves, if the most ventral lamella is termed I, will be as follows:—I, II, III, IV, V, VI, VII, VIII. The 8 anterior lamellæ which are separated by the ligament from the 8 posterior lamellæ give birth to the anterior lateral and cardinal teeth, while the posterior ones produce the posterior laterals, as will be seen in the following diagram, copied from Stefanescu's memoir.



According to this scheme the theoretical pelecypodian hinge is composed of 31 teeth, *viz.*,

8 Anterior laterals (La).
15 Cardinals (Ca).
8 Posterior laterals (Lp).

[1] Note préliminaire sur le développement de la charnière chez les Mollusques acéphales, 1895.
Deuxième note préliminaire sur la charnière des Mollusques acéphales. Compte-rendu des séances de la Soc. Géol. de France. Ser. III, vol. XXIII, page LIII—LVI, 1895.

[2] Etudes sur les Terrains tertiaires de Roumanie. Memoir. de la Soc. Géol. de France. Paléontologie. Mem. No. 15, 1896, page 23.

which, designating the laterals with *roman* and the cardinals with *arabic* numbers, the letter a=anterior and p=posterior being common to both, originate in the following manner.

a. *Right valve.*

The anterior primary lamella I forms the anterior lateral La I, and the principal cardinal tooth Ca1.

The anterior primary lamella III forms the anterior lateral La III, and two cardinal teeth Ca3a and Ca3p arranged in ∧ shape on the anterior and posterior side[1] of Ca1.

The anterior primary lamella V forms in a similar way the anterior lateral La V and the cardinals Ca5a and Ca5p arranged in ∧ shape on the dorsal side of Ca3a and Ca3p.

The anterior primary lamella VII forms the anterior lateral La VII, and the cardinals Ca7a and Ca7p arranged in a similar way on the dorsal side of Ca5a and Ca5p.

The posterior primary lamella I forms the posterior lateral Lp I.

The posterior primary lamella III forms the posterior lateral Lp. III.

The posterior primary lamella V forms the posterior lateral Lp V.

The posterior primary lamella VII forms the posterior lateral Lp VII.

b. *Left valve.*

The anterior primary lamella II forms the anterior lateral La II, and the two cardinals Ca2a and Ca2p arranged in ∧ shape.

The anterior primary lamella IV forms the anterior lateral La IV, and the cardinals Ca4a and Ca4p, arranged in ∧ shape on the dorsal side of Ca2a and Ca2p.

The anterior primary lamella VI forms the anterior lateral La VI and the cardinals Ca6a and Ca6p, arranged in ∧ shape on the dorsal side of Ca4a and Ca6a.

The anterior primary lamella VIII forms the anterior lateral La VIII, and the Cardinals Ca8a and Ca8p arranged in ∧ shape on the dorsal side of Ca6a and Ca6p.

The posterior lamella II forms the posterior lateral Lp II.

The posterior lamella IV forms the posterior lateral Lp IV.

The posterior lamella VI forms the posterior lateral Lp VI.

The posterior lamella VIII forms the posterior lateral Lp VIII.

This view may be summed up as follows[2]:—

Left valve.	*Right valve.*
	LA I = La I + Ca 1.
LA II = La II + Ca 2a + Ca 2p.	LA III = La III + Ca 3a + Ca 3p.
LA IV = La IV + Ca 4a + Ca 4p.	

[1] The term "dorsal" would perhaps be more appropriate.

[2] To make the scheme clearer I substitute for the letters LC, expressing the anterior lamella, the letters LA, and I arranged it in such a way as the teeth would follow if the valves were closed.

Left valve.	*Right valve.*
LA VI = La VI + Ca 6a + Ca 6p.	LA V = La V + Ca 5a + Ca 5p.
LA VIII = La VIII + Ca 8a + Ca 8p.	LA VII = La VII + Ca 7a + Ca 7p.
LP II = Lp II.	LP I = Lp I.
LP IV = Lp IV.	LP III = Lp III.
LP VI = Lp VI.	LP V = Lp V.
LP VIII = Lp VIII.	LP VII = Lp VII.

The complete, theoretic hinge of a Pelecypode could therefore be written in the following manner:—

La VIII, La VII, La VI, La V, La IV, La III, La II, La I + Ca 8a, Ca7a, Ca6a, Ca5a, Ca 4a, Ca 3a, Ca 2a, Ca 1, Ca 2p, Ca 3p, Ca 4p, Ca 5p, Ca 6p, Ca 7p, Ca 8p + Lp I, Lp II, Lp III, Lp IV, Lp V, Lp VI, Lp VII, Lp VIII.

Or in a more abbreviated way—

La : VIII, VII, VI, V, IV, III, II, I + Ca : 8a, 7a, 6a, 5a, 4a, 3a, 2a, 1, 2p, 3p, 4p, 5p, 6p, 7p, 8p + Lp : I, II, III, IV, V, VI, VII, VIII.

It will be seen that cardinals and laterals are therefore arranged symmetrically on both sides of the odd cardinal Ca 1.

As of course no Pelecypod is known which exhibits this complete hinge, Munier-Chalmas and Stefanescu suggest that the missing tooth should be represented by a O having as exponent the number of the missing tooth. For instance, the hinge of *Cyrena* would be expressed by the following formula:—

La : O^{viii} O^{vii} O^{vi} O^{v} IV, III, II, I + Ca o^{8}, o^{7}, o^{6}, o^{5}, o^{4}, 3a, 2a, 1, 2p, 3p, 4p, o^{5}, o^{6}, o^{7}, o^{8} + Lp : I, II, III, IV, O^{v}, O^{vi}, O^{vii}, O^{viii}.

or in a more abbreviated manner—

La : O^{viii-v} IV, III, II, I + Ca : O^{8-4}, 3a, 2a, 1, 2p, 3p, 4p, O^{5-8} + Lp : I, II, III, IV, O^{v-viii}.

The chief objections against this formula are its length, being encumbered with a lot of unnecessary figures, but particularly the impossibility to show at a glance the composition of the hinge in each valve, and if the hinge formula of *Cyrena* as expressed by this method will be compared with that on page 5 the great advantage of Bernard's formula is obvious.

The method followed by Professor Bernard[1] assumes the existence of three primary anterior and posterior lamellæ in each valve; the anterior lamellæ of the right valve, which are designated LAI LAIII and LAV, give birth to the anterior laterals, anterior and posterior cardinals, while from the posterior lamellæ, termed LpI, III and V, the posterior laterals arise; in a similar way the primary lamellæ LAII, LA IV and LA VI produce the anterior laterals, anterior and posterior cardinals, while the posterior laterals originate from the posterior primary lamellæ.

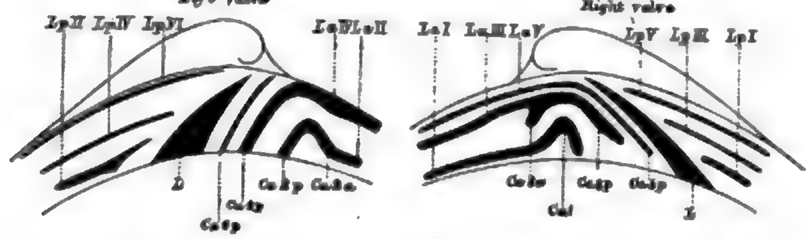
[1] Bull. de la Soc. Géol. de France, III ser., vol. 23, 1895, page 104 f.f.
" " III ser., vol. 24, 1896, page 54, f.f. and page 412 f.f.

For the recognition of the teeth in the full-grown valve the following table is given :—

Left valve.	*Right valve.*
CA2a = Anterior cardinal.	CA 1 = Median cardinal.
CA2b = Median cardinal.	CA3a = Anterior cardinal.
CA4b = Posterior cardinal.	CA3b[2] = Posterior cardinal.
LA II = Anterior lateral.	LA I = Ventral anterior lateral.
LP II[1] = Posterior lateral.	LA III = Dorsal anterior lateral.
	LP I = Ventral posterior lateral.
	LP III = Dorsal posterior lateral.

In the hinge of the ideal Pelecypod all the above-mentioned elements would be present, and Bernard illustrates his view of the development of the hinge by the following diagram :—

Fig. 2. Left valve. Fig. 2a. Right valve.



In framing the hinge formula Bernard differs considerably from the method as adopted by Munier-Chalmas, by giving the number of teeth separately for each valve and inserting the letter L to demonstrate the position of the ligament; the hinge formula of the genus *Cyrena* would, for instance, be as follows :—

Right valve	LA I : III	Ca 3a : 1 : 3b :	*L*	LP I : III.
Left valve	LA II	Ca 2a : 2b : 4b	*L*	LP II

Before discussing both methods it will be well to dwell a little on the technical advantages of each; if comparing the hinge formula of *Cyrena* as written according to the system of Munier-Chalmas with the same according to Bernard's method, it will be seen at a glance that the latter deserves the preference for its shortness and clearness. The hinge formula of *Cyrena*, according to Munier-Chalmas's system, does not convey the idea of its composition with the same clearness as that according to Bernard's system; in the latter the eye, and through it the mind, is not troubled with the sight of figures representing teeth which are non-existent, and at the same time the existence of teeth in each valve, their way of interlocking, the existence of sockets by the sign : is made as clear and conspicuous as possible.

[1] Erroneously printed LA II.
[2] Erroneously printed CA 2b.

At the same time it may, however, be doubted whether the introduction of the sign *L* to denote the place of the ligament is of any special value, considering that the posterior laterals are always separated from the cardinals by the ligament.

I think therefore that Bernard's system deserves preference, and I have adopted it with some minor alterations; I designated the cardinal teeth by the letter Ca instead of CA, reserving the capital A for the primary lamellæ, and substituting the letter p (=posterior) for b, in order to designate the posterior cardinals.

From the foregoing it will be seen that both Munier-Chalmas and Bernard have based their system of terminology on the development of the hinge; it is therefore obvious that unless the complete development of the hinge is known, the correct designation of the elements of a hinge from which the earlier stages are unknown, will meet with considerable difficulties. The homologies of the hinge of extinct as well as living species will therefore be always doubtful, until by a series of developmental stages the true value of each tooth has been recognised.

Bernard has to some extent mitigated this difficulty by applying his terms to the old terminology, thus rendering the identification of the teeth of a good many genera an easy task, even without the nealogic stages being known; but as he already himself remarked, the interpretation of some seemingly simple hinges, like those of the *Cardiidæ*, *Tellinidæ* and others is by no means easy. Unless it is proved by development that, for instance, the ventral cardinal tooth of *Cardium* is really Ca 1 this view may be questioned inasmuch as it might also represent Ca3p.

As excellent and concise this method is, when there is no question of homology, the above is a very serious drawback, which can only be remedied by diligent researches of the development of the hinge in the various genera of Pelecypoda, but the French scientists have opened a vast field of new research, which is sure to lead to some highly important results with regard to the evolution of Pelecypoda.

I may be permitted to indicate already a few directions to which Messrs. Munier-Chalmas and Bernard's theory of the hinge of Bivalves will lead to. Both accept the theory that all teeth have evolved from primary lamellæ, the number of which, whether 8 or 6, is of no great concern. Much more important is the shape of these lamellæ, and doubts may perhaps be permitted whether the primary lamellæ had the shape as depicted in Munier-Chalmas's diagram. It is much more probable, in fact it seems almost unquestionable, according to the figures given by Bernard, that the primary lamellæ were simple and plain ridges appearing originally on the anterior and posterior side of the cardinal margin (*vide* Bernard's fig. 1, page 108; fig. 4, page 115; fig. 12, page 127). The posterior primary lamellæ remained simple throughout the whole life, and no case is known in which secondary teeth originated from them, but whether originally or only subsequently, they are always anteriorly inclined, a feature which might be termed *prosocline*.

The anterior primary lamellæ, however, underwent various changes at their *posterior* end by thickening and curving, which eventually resulted in the differentiation of the cardinal teeth; it is noteworthy that in the differentiated primary

lamellæ, the anterior laterals are always, and the anterior cardinals mostly posteriorly inclined, *opisthocline*, while the posterior cardinals are always *prosocline*.

Leaving out the question which of the primary lamellæ, the posterior or anterior, originated first, and which is therefore the older side, and considering only the primary lamellæ, Bernard's figures seem to demonstrate to a certainty that at first the *anterior Cardinal* was formed at the posterior end of the primary lamella and by further growth the posterior cardinal developed. This would prove that:

(1) the anterior and posterior laterals are the oldest teeth of the Bivalve shell and should therefore be present only in the geological oldest species ;

(2) the anterior cardinal was formed afterwards, and is therefore younger than the laterals, but older than the posterior cardinal ;

(3) the posterior cardinal was formed latest and must therefore be considered as the youngest of all teeth ; geologically old species could therefore have no posterior cardinals.

The above refers of course only to the teeth originating from one and the same primary lamella, but as there are supposed to be 6 or even 8 primary lamellæ, one following on the dorsal side of the other, the great question arises which of these is the oldest? A satisfactory answer to this question is of vital importance for the comprehension of the hinge of the bivalves, and I will attempt to answer it, as far as I am able to judge from the material at my disposal. I wish, however, at once to say, that a satisfactory solution will only be arrived at by actual observation of the development of the hinge of heterodont bivalves.

I regret however to say that, as far as it seems to me, there exists a principal difference of view between Messrs. Bernard and Munier-Chalmas. Bernard states distinctly that Lp IV. or 4*a* appear on the *dorsal* side of the lamella II, that is to say, after the formation of teeth resulting from this primary lamella, while in the right valve another lamella, which might be termed V, develops on the dorsal side of III. Bernard is quite clear in this case, so that there can be no doubt as to his opinion.

The logical consequence is therefore that the primary lamella LAI would be the oldest and the primary lamella LA VIII the youngest. The hinge of geologically old species would therefore result from the development of some of the ventral lamellæ, while it would necessarily follow that the hinge of the geologically younger specimens would result from the development of the dorsal lamellæ.

This seems to be an untenable view, and in going through the figures as given by Bernard one cannot suppress the notion that it is the most ventral lamella LA I which appears latest, and not earliest ; we see, for instance, in fig. 12-2 the dorsal lamella LA III in a much more differentiated state than the ventral lamella LA I, a feature which is still more emphasized in fig. 12-3, and only when the dorsal lamella LA III is fully developed, the ventral lamella LAI begins to differentiate.

The view that the dorsal primary lamellæ are older than the ventral ones, is further supported by the fact that all Bivalves grow in ventral direction, in other words, the ventral portions of a bivalve shell are younger than the dorsal ones ; it would be certainly strange if the opposite took place with regard to the hinge,

were the ventral parts would be the older and the dorsal parts the younger, ones; that is to say, the hinge would grow just in the opposite direction as the remainder of the shell.

The view that the dorsal primary lamellæ are older than the ventral ones, finds a further very strong support in development of the hinge of *Pectunculus* and *Arca* as given by Bernard himself; here the increase of lamellæ takes place at the ventral side of the first one, and the more lamellæ which appear ventrally, the more the older ones move dorsally and internally until they disappear entirely.

If we further consider Munier-Chalmas' diagram[1] the view that the increase of primary lamellæ takes place from the dorsal side seems entirely impossible, while the notion of an increase and growth from the ventral side meets with no difficulty.

Taking everything into consideration, I am therefore of the opinion that the ventral primary lamellæ are the youngest, and that an increase of number takes place on the ventral and not on the dorsal side. Shells having a hinge resulting from the evolution of ventrally situated lamellæ, would therefore represent a modern type, while others in which the hinge has developed from the more dorsal lamellæ represent a more archaic type. It is quite in harmony with this view that in shells where teeth resulting from the primary lamellæ LAV and VI are present, these latter are more or less rudimentary; the appearance of new lamellæ on the ventral side forced the dorsal ones in the background, exactly as has been noticed in the evolution of the hinge of *Pectunculus* and *Arca*. The teeth resulting from such lamellæ, if present at all, will be always more or less rudimentary; this is fully borne out by actual observation, as, for instance, Ca5p or Ca6p are always rudimentary, but no instance is known to me where both are very strong while Ca 1 is rudimentary. But, on the other hand, there is no reason why the more dorsal teeth should not be strong and the younger ventral ones weak, as in the genus *Mactra*, because the development of the latter is of recent origin, they having not had time to develop to full strength.

I am, unfortunately, not in the position to give some more instances but one to prove the above view, but I think that there will be no disagreement in the statement that *Cardita* represents a geologically older type than *Venus*. Now the hinge of *Cardita* s.s. presents a close relationship to that of the *Veneridæ*, but in the former Ca 1 is absent, while there is a more or less rudimentary Ca5p; in the majority of the Veneridæ Ca5p has entirely disappeared, Ca4p has become more or less rudimentary, while Ca 1 has been strongly developed. The result of the above argumentation is therefore the following:—

The dorsal primary lamellæ are older than the ventral ones, and teeth developed from the former are therefore older than those from the latter; in teeth being developed from one and the same primary lamella, the anterior laterals are the oldest, then follow the anterior cardinals, and the latest the posterior cardinals.

If the above theory is correct, we are to some extent able to foretell the next change in the bivalve hinge; this would most probably be the evolution of a posterior cardinal from the primary lamella LA I. For the present only La I and Ca 1

[1] See above page 2.

are differentiated from it, but as it has been demonstrated that the posterior cardinals develop later than the anterior ones, the chances are greatly in favour of the development of a posterior cardinal Ca1p, which would be interlocked between Ca2pα and Ca2pβ which are already developed in the genus *Tapes* where they are separated by a pseudo-socket, *i.e.*, a socket into which no tooth fits, while at the same time the mollusk exhibiting such a tooth will have probably no posterior cardinals of the higher order which may have disappeared.

On the following pages the results of the examination of the hinges of some recent and miocene genera are given, which being based on Messrs. Munier-Chalmas and Bernard's methods, have revealed some remarkable features in the development of the hinge. The genera described can be classified in three groups, *viz.:*

1. The first group, including the genus *Cardita* and the Family *Veneridæ*, is distinguished by the reduction of the anterior and posterior laterals with regard to number and strength; on the other hand, the cardinals have strongly developed with regard to their thickness, though there is unquestionably a tendency towards the reduction of number by resorption of the posterior cardinals of higher order.

2. The second group comprises the genus *Mactra*. In this genus just the reverse takes place as in the first group; the anterior and posterior laterals are strongly developed with regard to number and strength; on the other hand, the cardinals are almost rudimentary while their number is greatly reduced.

3. The third group is represented by the genus *Meiocardia*; in this genus laterals and cardinals are neither reduced in number nor has the strength of one been increased at the expense of the other; the peculiar feature is that originally separate teeth, originating from different primary lamellae, have become amalgamated and form *composite teeth*, which hardly allow their primary elements to be traced. An originally complex hinge has therefore become simplified not by disappearance of some of its elements, but by amalgamation of some of them, a feature which has not been noticed in either of the two preceding groups.

I refrain from dwelling any further on this subject, because my observations are too limited, and further proofs are required to decide whether the above three groups of development of the bivalve hinge are universal or not, but I wish at once to say that I do not want to base any system on the above features. Future researches may perhaps prove that they are of some classificatory value, but much will have to be done to achieve this end. The hinge of genera like *Cardium*, *Gari*, *Telina*, etc., will first have to be thoroughly studied before anything definite can be said.

II.—DESCRIPTIVE PART.

1. Genus: CARDITA. Brugière.

The genus *Cardita* has been split up in a number of subgenera, which are chiefly based on the difference of external features, such as general outline, ornamentation, etc., but in the definition of subgenera, the important character of the hinge has been almost disregarded. This is probably chiefly because of the absence of a fixed

terminology defining the variations of the hinge, which although well-known, could not be expressed by words.

According to Bernard the hinge formula[1] of *Cardita* is as follows :—

Right valve La (I) :	Ca (3a) :	3p :	(5p)	*L*	Lp o.
Left valve La (II)	Ca 2a :	4p		*L*	Lp o.

The posterior laterals are therefore always absent, the anterior laterals, as well as the cardinals 3a and 5p, may be present, or absent. It is quite obvious that under these circumstances the hinge of *Cardita* allows for a good number of variations; if all teeth were present the hinge would be composed of 7 teeth, two anterior laterals, two anterior and three posterior cardinals, but it may be reduced to 3 only, *viz.*, one anterior and two posterior cardinals.

From a systematic point of view, such a variation would afford a vast field for the creation of new subgenera, when in addition the characters of shape and ornamentation are considered, and I have no doubt that some well-defined groups or subgenera can be circumscribed, but within these groups, the variation of the hinge should be studied from an evolutionary point of view, as the result of such an investigation would certainly be most valuable.

The hinge of *Cardita* is certainly very interesting from an evolutionary point of view, because of the absence of Ca 1. As has been pointed out before, Ca 1 is that tooth which in the order of succession makes its appearance latest. A hinge without Ca 1 has therefore an antiquarian look, and we must therefore apply this term to the hinge of *Cardita*.

Bernard has already drawn attention to the great relationship of the hinges of the *Carditæ* and *Veneridæ*, a relationship which is unquestionably very marked. As this subject will, however, be dealt with when the hinge of the *Veneridæ* is discussed, it would be unnecessary to enter into the question at this place.

The Miocene of Burma has yielded two species of *Cardita*, *viz.*, *Cardita protovariegata*, Noetl., belonging to the subgenus *Mytilicardia* and closely related to the living *Cardita* (*Mytilicardia*) *variegata* and *Cardita viquesneli*, D'Arch., which certainly, owing to its entirely different shape and ornamentation, cannot be included in this subgenus. *Venericardia*, to which the triangular shells of the type of *Cardita viquesneli* have been added, differs by its hinge, and I leave therefore the subgeneric position of this species undecided. The comparative study of the hinge of these two species affords a great interest, particularly when the hinges of *Cardita* (*Mytilicardia*) *protovariegata* and *Cardita* (*Mytilicardia*) *variegata* are compared and analysed, because a certain line of evolution seems to be indicated, which might throw some light on the peculiarities of the hinge of *Cardita*.

To judge from Bernard's diagram of the hinge of *Cardita imbricataria* of 0·8 mm. size, Ca3a was at that stage considerably larger than Ca3p; it is therefore unquestionable that during the development of that species the relative size of Ca3a and Ca3p have undergone a perfect change, Ca3p being the larger in the

[1] There appears to be a misprint in the formula as given by Bernard, as nothing is mentioned of the presence of La III, and I suppose it should read La I, which would be in concordance with the description of the hinge; I have therefore altered the formula accordingly.

adult stage. The two miocene species, particularly *Cardita protovariegata*, have, a comparatively speaking, a large Ca3a, but in the living *Cardita variegata* this tooth is reduced to almost an imperceptible granule. The same applies to Ca2a in the left valve, though the reduction has not gone to the same extent as in the left valve.

It seems therefore that in the genus *Cardita* the anterior cardinal tooth Ca3a was originally larger than Ca3p, a feature which is well exhibited in the nealogic stage of *Cardita imbricataria*, and that it became eventually smaller in size than Ca3p as exhibited in *Cardita* (*Mytilicardia*) *protovariegata* from the miocene, and that at last it became reduced almost to obliteration in the living *Cardita variegata*, while Ca3p became very large. The supposition that the ancestors of *Cardita* were provided in the right valve with a large anterior cardinal tooth Ca3a, which probably exceeded the posterior cardinal Ca3p, is therefore proved by the ontogenic development of *Cardita imbricataria* as well as by the comparative study of *Cardita* (*Mytilicardia*) *protovariegata* and *Cardita* (*Mytilicardia*) *variegata*

The study of Bernard's figure further teaches that originally Ca3a and Ca3p joined in a pointed angle underneath the umbo, Ca3a being opisthocline, Ca3p prosocline; we must therefore consider this as the original relative position of Ca3a and Ca3p. Now in comparing the hinges of the three species here described, it will be seen that in *Cardita viquesneli* the original position of the two teeth is almost retained; in *Cardita subvariegata* they still form a pointed angle, but Ca3p is anteriorly produced and Ca3a is no longer opisthocline, but runs almost perpendicular to the ventro-dorsal axis; in the living *Cardita variegata* this feature is developed to the extreme, inasmuch as Ca3p is still more prosocline while Ca3a is reversed, so that its posterior or ventral side faces now in dorsal direction having become prosocline in fact.

We may express this also in the following way; in the left valve of *Cardita* the anterior cardinal Ca2a was originally opisthocline; in the course of the development its apex was turned in anterior direction till it became prosocline and at last almost horizontal; various species exhibit of course different stages; in the nealogic stage of *Cardita imbricataria*, as well as in the adult stage of *Cardita viquesneli*, Ca2a is opisthocline; in the adult stage of *Cardita* (*Mytilicardia*) *subvariegata* it is almost perpendicular, perhaps already slightly prosocline, and in the adult stage of *Cardita* (*Mytilicardia*) *variegata* is almost horizontal.

Unfortunately nothing is known about the development of Ca5p; it is well developed in *Cardita viquesneli* and *Cardita* (*Mytilicardia*) *protovariegata*, but it has almost absolutely disappeared in the recent *Cardita* (*Mytilicardia*) *variegata*. A tendency towards the obliteration of this tooth is therefore unquestionably indicated in the instance of *Mytilicardia variegata*.

The same applies to the anterior laterals which always seem to be in a rudimentary state.

We may therefore conclude that all species of the genus *Cardita* in which the anterior cardinal Ca3a of the right valve is strongly developed, but particularly those in which the posterior cardinal Ca3p is weaker than the anterior one and which have an opisthocline anterior cardinal Ca2a in the left valve, bear an archaic

habitus; the existence of the posterior cardinal Ca5p, and probably also of anterior laterals, may strengthen the archaic character.

The hinge of *Cardita viquesneli* certainly answers to some degree this postulate, and it is certainly not a mere accident that shells of this type, that is to say, triangular shells with simple, thin, radiating ribs, are very common in Eocene strata while there is hardly a living relative.

CARDITA (Mytilicardia) variegata Brugière. Plate II, fig. 1, 1a.

a. *Right valve.*

1. Anterior lateral teeth: missing.

2. Cardinal teeth.

Very close to the edge of the anterior margin and almost coalesced to it, there is a rudimentary small, slightly prosocline tooth; although its inclination is reversed it is unquestionable that it represents Ca3a though in an almost obsolete state. On its posterior (ventral) side is a short transverse triangular socket. Behind it follows a large, slightly curved triangular tooth, broad at its base, accuminated towards its apex, Ca3p; it is so strongly prosocline that its anterior side faces ventrally and runs parallel to the antero-posterior axis; its posterior or dorsal side bears a number of fine transverse plications just as seen sometimes in the genus *Unio* or *Cyrena*. On the posterior (dorsal) side of Ca3p there is an elongate transverse and anteriorly inclined socket, followed by the strong ligamental nymphe; it appears as if there were indications of a rudimentary Ca5p, which become however entirely coalesced to the ligamental nymphe.

3. Posterior lateral teeth : missing.

b. *Left valve.*

1. Anterior lateral teeth : missing.

2. Cardinal teeth.

Immediately underneath the umbo, and parallel to the antero-posterior axis, there is a short, strong transverse tooth Ca2a, having on its anterior (dorsal) side a short, longitudinal, and on its posterior (ventral) side a deep triangular socket, which is followed by a very long, slightly curved and prosocline tooth Ca4p, very finely plicated on its posterior (dorsal) side. Then follows a rudimentary narrow socket and then the ligamental nymphe.

3. Posterior lateral teeth : missing.

The hinge formula is therefore—

Right valve	La O	Ca (3a) : 3p : (5p)	*L*	Lp O.
Left valve	La O	Ca : 2a : 4p :	*L*	Lp O.

Remarks.—The hinge of *Cardita* (*Mytilicardia*) *variegata* is remarkable in several regards which are of great interest. Considered as a whole the hinge is distinguished by the small number of teeth still in existence, there being no traces

of anterior laterals; and though present, Ca3a and still more so Ca5p are so extremely rudimentary that they are hardly noticed; in fact only three teeth, Ca3p Ca2a and 4p, are conspicuous.

Another noteworthy feature are the transverse plications[1] on the posterior (dorsal) side of Ca3p and Ca4p, which strongly remind of similar plications in the genus *Unio* on *Cyrena*.

The whole aspect of the hinge, particularly the rudimentary development of its anterior portion, the strange reversed inclination of Ca3a and Ca2a, are very remarkable, and appear to indicate an evolutionary feature, as it is difficult to suppress the notion that the tendency exhibited is towards the direction of a reduction in the number of teeth, which has been partly achieved by the coalescence of Ca5p with the ligamental nymphe, partly by the disappearance of the anterior teeth, which seems to have been produced by the strong anterior inclination of the umbonal region; this inclination is so strong that Ca3a and Ca2a were perfectly reversed, that is to say, as is particularly remarkable in Ca3a, instead of being opisthocline as they ought to be, they are prosocline, and therefore the posterior side which was originally facing ventrally is now facing dorsally and *vice versâ*. In the same way both Ca3p and Ca4p are extremly prosocline.

CARDITA (Mytilicardia) protovariegata, Noetling. Plate II, fig. 2, 2a.

a. *Right valve.*

1. Anterior lateral teeth : missing.
2. Cardinal teeth.

Close to the anterior margin there is a long lamellar tooth Ca3a which is almost parallel to the ventro-dorsal axis, perhaps slightly prosocline, having on its posterior (ventral) side a long triangular socket running almost parallel to it. The large triangular prosocline tooth Ca3p has a very broad basis; on its posterior (dorsal) side there is an elongate, narrow socket, followed by a long lamellar tooth Ca5p, running nearly parallel to the posterior (dorsal) side of Ca3a, and so strongly prosocline that it is almost horizontal, *i.e.*, parallel to the antero-posterior axis. The ligamental nymphe is so strong that it almost resembles another posterior tooth, and it might therefore easily be mistaken for Ca7p.

3. Posterior lateral teeth missing.

b. *Left valve.*

1. Anterior lateral teeth : missing.
2. Cardinal teeth.

Close to the margin is a narrow socket running almost parallel to the ventro-dorsal axis, having on its posterior (ventral) side an elongate strong tooth Ca2a which is just perceptibly prosocline; on the ventral side of Ca2a follows a large

[1] As far as I know a similar feature has only been observed in *Cardita dunkeri*, Phil. (v. Koenen, Nord-

deep triangular socket, which has on its posterior side a long thin lamellar tooth, strongly prosocline and almost touching the apex of Ca2a; this tooth, Ca4p, has a deep, elongate and narrow socket on its dorsal side, followed by the strong ligamental nymphe which almost resembles another posterior cardinal.

The hinge formula is therefore as follows:—

Right valve	La. O	Ca. 3a	:	3p	:	5p	*L*	Lp. o.
Left valve	La. O	Ca.	2a	:	4p	:	*L*	Lp. o.

Remarks.—If this hinge formula is compared with the general formula as given above, it will be seen that it chiefly differs by the absence of the anterior laterals, and by the presence of a strongly developed Ca3a and Ca5p.

The chief interest rests however in a comparison with the recent *Cardita* (*Mytilicardia*) *variegata.* Taken as a whole, it will be seen that the miocene species contains one tooth more, *viz.*, Ca5p, which is still strongly developed, but which has entirely disappeared in the recent species. It will further be seen that Ca3a, though present, is almost rudimentary in the recent species, while in the miocene species it is rather strong.

While in the living species the apex of Ca3a is strongly prosocline and the tooth therefore reversed, it is just slightly prosocline in the miocene species; Ca3p is therefore not so strongly prosocline and therefore Ca2a is not horizontal as in *Cardita* (*Mytilicardia*) *variegata*, but almost perpendicular, and only slightly turned prosocline.

CARDITA VIQUESNELI, D'Archiac and Haime. Plate II, fig. 3, 3a.

a. *Right valve.*

1. Anterior lateral teeth.

Close to the anterior margin there is a small circular socket, having on its ventral side a very rudimentary granular prominence La I.

2. Cardinal teeth.

Almost amalgamated to the anterior margin is a strong, but short strongly opisthocline tooth Ca3a. On its posterior (ventral) side is a deep elongate socket, and behind it the large triangular tooth Ca3p, having its apex right underneath the umbo; its anterior side being posteriorly, its posterior side anteriorly inclined.

Parallel to its posterior side runs a narrow elongate socket, having on its posterior side, amalgamated to the ligamental nymphe, an elongate tooth Ca5p.

3. Posterior lateral teeth: missing.

b. *Left valve.*

1. Anterior lateral teeth.

Close to the anterior margin there is a rudimentary granular tooth, the axis of which runs almost parallel to the antero-posterior axis, representing La II.

2. Cardinal teeth.

There is a short, strongly opisthocline tooth, Ca2a, having a deep socket on its anterior dorsal side, and separated by a triangular socket, from an elongate lamellar, strongly prosocline tooth Ca4p, which touches the apex of Ca2a; on the dorsal side of Ca4p is a very elongate socket running parallel to it, and then follows the ligamental nymphe.

3. Posterior lateral teeth: missing.

The hinge formula is therefore—

Right valve La. : I	Ca 3a : 3p : (5p)	*L*	Lp. o.
Left valve La. II	Ca 2a : 4p :	*L*	Lp. o.

Remarks.—Among the species here described *Cardita viquesneli* has the largest number of teeth, *viz.*, seven; it must, however, be remarked that the laterals are rudimentary and that Ca5p is almost amalgamated to the ligamental nymphe.

The arrangement of the anterior cardinals is however of great interest; while in the living *Cardita (Mytilicardia) variegata* they were reversed, and slightly prosocline in *Cardita (Mytilicardia) subvariegata*, they are strongly opisthocline in this species, that is to say, they retain the normal inclination. The result is that the anterior side of Ca3p is posteriorly inclined, while it is anteriorly inclined in *Cardita (Mytilicardia) subvariegata* and horizontal in *Cardita (Mytilicardia) variegata*.

Family: *VENERIDÆ*, Stoliczka.

The large family of Veneridæ is distinguished by a very characteristic hinge composed of 3 anterior lateral, 7 cardinal and 3 posterior lateral teeth, according to the following formula:—

Right valve La. III : I	Ca. 3a : 1 : 3p : (5p)	*L*	Lp. III : I
Left valve La. II	Ca. : 2a : 2p : 4p	*L*	Lp. ' I

It is remarkable that with very few exceptions the number of the cardinal teeth remains constant, and does not exceed six, because Ca5p is absent in the majority of genera; in a few Ca4p is also absent or very rudimentary, and the number of cardinals may, therefore, be reduced to 5. The lateral teeth, on the other hand, are subjected to great variations with regard to strength. Fisher has based a sub-division of the family on this character, and there is no doubt that his view is an exceedingly good one, as even in specimens older than of tertiary age, the absence or presence of lateral teeth may be recognised. As far as I am able to judge, the general character of the laterals is very constant, though in detail they undergo great variations; if present the anterior laterals are always stronger than the posterior laterals, and in any case the anterior lateral La II of the left valve, the so-called lunular tooth, is always much stronger than the laterals La I and La III of the right valve, of which the latter appears to be generally the weaker. It is unquestionable that the presence of the large anterior lateral La II forms a very good distinctive feature of genera like *Cytherea*, *Dione*, *Dosinia*, etc.

With regard to the cardinal teeth a general plan seems to be observed throughout the family, a plan which, as far as my limited experience allows to judge for, seems to be based on the following scheme:—

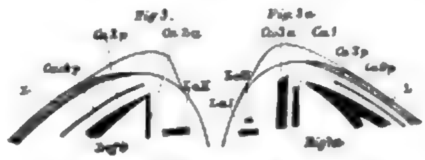


Diagram of the hinge of Veneridae.

In the left valve there is always a composite ∧-shaped tooth turning its apex in dorsal direction, originating from the union of Ca2a forming the anterior, and Ca2p the posterior side; Ca4p is generally very thin, lamellar, mostly amalgamated to the ligamental nymphe, sometimes absent; in fact it seems as if this tooth were the least constant element of the cardinal teeth.

In the right valve there are two lamellar teeth Ca3a and Ca 1, in close proximity, separated by a slit-like socket, stretched in the ventro-dorsal direction. Behind there is a large, usually bifid, strongly prosocline tooth Ca3p, which frequently becomes joined to Ca3a, thus encircling Ca 1; there may be also a rudimentary Ca5p, but it is almost always missing, or, if present, amalgamated to the ligamental nymphe.

The angle which these various elements form among each other, their relative size and strength, allow for a large number of variations, such as compose the family of Veneridæ; a comparative study of these numerous variations would be of a great value from a palæontological point of view.

The great relationship between the hinges of the *Veneridæ* and *Carditæ* has already been referred to, and if we analyze both hinges we see that the hinge of the *Carditæ* can be easily derived from that of the *Veneridæ*, if Ca 1 in the right and Ca2p in the left valve were to disappear. We would then have the same elements as those constituting the hinge of the *Carditæ*, in particular the large triangular posterior cardinal Ca3p.

Diagram of the hinge of Carditae.
Fig. 4. Fig. 4a.

Now as the whole theory of the evolution of the hinge requires that Ca 1 and Ca2a appear after Ca3p and Ca4p had been formed, we might assume, the hinge of the *Veneridæ* has been derived from that of the *Carditæ* by the development of a posterior cardinal Ca2p out of the primary lamella LA II, and the evolution of Ca 1 out of the primary lamella LA I which had already produced La I.

The hinge of the *Veneridæ* presents, therefore, an unquestionably modern appearance, and it would be interesting to know when the true *Veneridæ* made

their first appearance, as in the face of the above reasoning the occurrence of true *Veneridæ* in the middle Jurassic formation may perhaps be questioned.

Whether the *Veneridæ* have evolved from the *Carditæ*, or whether both have a common ancestor, remains an open question which might perhaps be solved by the examination of the hinge of true *Veneridæ* from the lower tertiary and cretaceous formation.

On the following pages the hinges of the following genera have been described :—

a. Subfamily : *Meretricinæ*, Fischer.
- 1. Genus : *Venus*, Linné.
- 2. Genus : *Chamelæa*, Klein.

b. Subfamily : *Venerinæ*, Fischer.
- 1. Genus : *Cytherea*, Lamack.
- 2. Genus : *Circe*, Schumacher.
- 3. Genus : *Dione*, Grey.
- 4. Genus : *Dosinia*, Scopoli.

c. Subfamily : *Tapetinæ*, Fischer.
- 1. Genus : *Tapes*, Megerle.

Of course this is only a very insignificant number, and further researches are required before the variation of the hinge of the *Veneridæ* is fully known. The comparative study of the hinges of these genera, particularly as some miocene species could be examined, has, however, resulted in some interesting facts which should not be disregarded by Palæontologists.

Subfamily: MERCTRICINÆ, Fischer.

1. Genus : VENUS, Linné.

The hinge of *Venus* and allied genera is readily distinguished from those grouping around *Cytherea* by the absence of La II in the left valve; in fact it appears as if the entire absence of anterior laterals and the presence of rudimentary, thin posterior laterals was one of the chief distinguishing features of the hinge of *Venus*; with regard to the cardinal teeth, not only Ca3p and Ca2p are deeply notched as in the genus *Chamelæa*, but Ca 1 is also deeply notched and almost bifurcated. I am, however, not quite sure how far this character is generic or specific, as I had only one species for examination. If proved to be general, it should form an exceedingly good distinguishing character.

The hinge formula is as follows :—

Right valve	La. O	Ca. 3a : 1 : 3p : 5p	*L*	Lp. : (I).
Left valve	La. O	Ca. : 2a : 2p : 4p	*L*	Lp. (II).

Venus puerpera, Linné. Plate II, fig. 5—5a.

a. Right valve.

1. Anterior lateral teeth.

The anterior laterals have entirely disappeared and no traces can be discovered.

2. Cardinal teeth.

The anterior cardinal Ca3a is close to the margin, strong, compressed in ventro-dorsal direction and so strongly opisthocline that it appears almost horizontal, imitating to some degree the lunular tooth of *Cytherea*, *Dione*, etc., which is, as must not be forgotten, invariably in the left valve. The central cardinal tooth Ca 1 is broad at the base, attenuated at the apex, almost parallel to the ventro-dorsal axis, deeply notched, the posterior portion being the lower; on its posterior (dorsal) side is a deep socket, and then follows the deeply notched Ca3p, which almost appears like two teeth joined with their sides; it is strongly prosocline, broad at the base, divided into a shorter but higher and a longer but lower branch; behind it is a deep socket and then follows the strong very elongate ligamental nymphe.

3. Posterior lateral teeth.

There is a very rudimentary, lamellar prosocline tooth Lp I, having a shallow socket on its dorsal side.

b. *Left valve.*

1. Anterior lateral teeth.

The anterior lateral teeth are missing; no traces can be found.

2. Cardinal teeth.

The anterior cardinal Ca2a is strong, thorn-like, opisthocline, having a deep socket on either side; Ca2p is strongly prosocline, broad at its base, and deeply notched, the anterior portion being slightly shorter than the posterior one. Behind it is a deep socket, and then follows close to the ligamental nymphe and amalgamated to it, the long lamellar, strongly prosocline Ca4p; the anterior half of which is much higher than the posterior one. Then follows the elongate strong ligamental nymphe.

3. Posterior lateral teeth.

There is only one rudimentary posterior lateral LpII of a low lamellar shape.

The hinge formula is therefore—

Right valve	La. O	Ca 3a : 1 : 3p :	*L*	Lp : (I).
Left valve	La. O	Ca : 2a : 2p : 4p	*L*	Lp (II).

Remarks.—The hinge of this species is distinguished by the complete disappearance of the anterior laterals and the hardly perceptible, almost obsolete posterior laterals. On the other hand, a remarkable feature has developed on the cardinals Ca 1, Ca2p, Ca3p, which are all deeply notched, while in the genera *Cytherea*, *Dione* and *Dosinia* only Ca3p is notched.

2. Genus: CHAMELÆA, Klein.

The genus *Chamelæa* is considered by most authors as a section of the subgenus *Chione*, Megerle. I do not wish to discuss this question, as it is quite certain

that whatever the generic value of *Chamelæa* may be, the hinge of the species here described differs considerably from that of the genus *Venus*.

In the first instance it is distinguished by the presence of anterior and posterior laterals which, though rudimentary, are distinctly discernible; both anterior and posterior laterals are thin, elongate, and by this character the anterior laterals differ widely of those of the genus *Cytherea* and its allies.

The cardinal teeth are the same as those of *Venus*, but Ca4p is less strongly developed, Ca2p and Ca3p are deeply notched, while Ca 1 is only slightly notched.

The hinge formula is as follows :—

Right valve	La (III) :	Ca 3a : 1 : 3p :	*L*	Lp (I).
Left valve	La (II)	Ca : 2a : 2p : 4p	*L*	Lp : (II).

CHAMELÆA TRISTIS, LINNÉ. Plate II, fig. 4—4a.

a. *Right valve.*

1. Anterior lateral teeth.

Close to the anterior margin there is an elongate but almost rudimentary opisthocline tooth, which fits into a socket between two similar teeth of the left valve, and must therefore be considered as La III.

2. Cardinal teeth.

Close to the anterior margin is a short, strongly opisthocline tooth Ca3a, separated by a deep but narrow socket from Ca 1; the latter is broad at its base, slightly prosocline and slightly notched, followed at its dorsal (posterior) side by a broad socket; behind this is a large strongly prosocline tooth Ca3p, which is the strongest of all and slightly bifid; behind it is a narrow shallow socket and then follows supported by a strong nymphe the ligament.

3. Posterior lateral teeth.

There is one elongate, curved and prosocline almost rudimentary tooth having a shallow socket on its dorsal side which must be considered as Lp I.

b. *Left valve.*

1. Anterior lateral teeth.

There is one almost rudimentary, elongate and opisthocline anterior lateral, having a shallow socket on its dorsal side which certainly represents La II.

2. Cardinal teeth.

Close to the margin, but separated by a deep socket from it is a slightly opisthocline short lamellar tooth Ca2a, separated by a deep but narrow socket from a short, broad, prosocline bifid tooth Ca2p, having on its dorsal side a rather broad and long socket, which is followed by a rudimentary lamellar, prosocline tooth Ca4p, close to the strong ligamental nymphe.

3. Posterior lateral teeth.

There is an elongate almost rudimentary prosocline posterior lateral La II, having a shallow socket on its ventral side.

The hinge formula is therefore—

Right valve	La (III) :	Ca 3a : 1 : 3p :	*L*	La (I).
Left valve	La (II)	Ca : 2a : 2p : 4p	*L*	La : (II).

Remarks.—Though the development of the cardinal teeth is exactly the same as that of *Dione*, the hinge differs considerably in the development of the laterals, particularly the anterior laterals; the lunular tooth La II which forms so conspicuous a feature of the genus *Cytherea* or *Dione* is entirely absent, and instead of such a strong tooth there is an almost rudimentary lateral.

Subfamily: VENERINÆ., Fischer.

3. Genus: CYTHEREA, Lamarck.

The hinge of *Cytherea* and allied genera is particularly distinguished by a large anterior lateral La II, the so-called lunular tooth in the left valve; this tooth is generally very strong, compressed in dorso-ventral direction, always strongly opsthocline, and often almost parallel to the antero-posterior axis, *i.e.*, horizontal. With regard to the cardinal teeth, Ca2a and Ca2p of the left valve form a peculiar composite tooth, the posterior portion of which is very strong and thick, while the anterior portion, Ca2a, is thin and lamellar; the apex is more or less flattened and not pointed as in *Dione*.

Unless it is a specific feature of the species here described, which I am unable to say with certainty for the moment, the hinge of *Cytherea* differs from that of all the other allied genera by the absence of Ca4p, which is either entirely missing or so rudimentary that it becomes amalgamated to the ligamental nymphe; in this regard *Cytherea* resembles closely to *Dione* where we notice a very rudimentary but still discernible Ca4p. The hinge formula is as follows:

Right valve	La (III) : I	Ca 3a : 1 : 3p	*L*	Lp (III) : (I).
Left valve	La II	Ca : 2a : 2p :	*L*	Lp (II).

CYTHEREA ERYCINA, Favanne. Plate III, Fig. 1—1a.

a. ***Right valve.***

1. Anterior lateral teeth.

The anterior laterals are almost obsolete, very short, knob-like, on both sides of a very deep, elongate socket; the ventral one La I is a little longer than the almost granular dorsal one La III, which is close to the margin.

2. Cardinal teeth.

The anterior cardinal tooth Ca3a is lamellar, rather high and slightly prosocline, having on its posterior (ventral) side a narrow slit-like socket, which is followed by a little stronger prosocline tooth Ca 1; on its posterior (dorsal) side is a broad and deep socket; behind it is a lamellar, strongly prosocline tooth Ca3p, which is the longest of all, separated by a long, narrow socket from the ligamental nymphe.

3. Posterior lateral teeth.

There are two elongate, thin, lamellar, posterior laterals separated by a shallow socket, Lp I and Lp III, the latter of which is almost amalgamated with the margin.

b. *Left valve.*

1. Anterior lateral teeth.

There is a very strong, high, elongate, opisthocline tooth La II, having a deep socket on its dorsal and a less deep one on its ventral side.

2. Cardinal teeth.

The anterior cardinal tooth Ca2a is thin, lamellar, slightly prosocline, having on both sides deep almost parallel sockets; its apex is amalgamated with the broad, thick, strongly prosocline Ca2p; this tooth, which is the strongest of all teeth of the hinge, is separated by a deep furrow from the ligamental nymphe.

3. Posterior lateral teeth.

There is a very elongate, thin, prosocline Lp II, having a shallow socket at its ventral side.

The hinge formula is therefore :

Right valve	La (III) : (I)	Ca 3a : 1 : 3p	*L*	Lp (III) : (I).
Left valve	La II	Ca : 2a : 2p :	*L*	Lp (II).

Remarks.—Although the hinge contains the characteristic lunular tooth La II in a fine development, it differs from the typical hinge by a smaller number of cardinal teeth in the left valve, in particular by the absence of Ca4p; I am, however, not quite sure whether this tooth is really missing or whether it becomes so entirely amalgamated to the ligamental nymphe at the full-grown stage that it cannot be discerned any longer; juvenile stages should be examined to settle this question.

4. Genus: CIRCE, Schumacher.

With regard to the composition and arrangement of the teeth the hinge of *Circe* resembles greatly to that of *Cytherea*; particularly with regard to the composite trapezoidal tooth Ca2a + Ca2p in the left valve; in all the other genera here described both teeth are either separated, or, if united, they form a pointed tooth, as, for instance, in the genus *Dione*, and not flattened at the apex as in *Circe* and *Cytherea*. The chief difference rests in the presence of Ca4p, which is rather strong and well developed in this genus; as already stated, Ca4p is either entirely missing in the genus *Cytherea* or it is so rudimentary that it has become entirely amalgamated to the ligamental nymphe.

The lateral teeth call for no special remark, as the anterior lateral LaII is strongly developed in the same way as in *Cytherea*, while the posterior laterals are very rudimentary in both valves.

The hinge formula is as follows :—

Right valve	La (III) : I	Ca 3a : 1 : 3p :	*L*	Lp (III) : (I).
Left valve	La II	Ca : 2a : 2p : 4p	*L*	Lp (II).

Circe castrensis, Linné. Plate III, fig. 2—2a.

a. *Right valve.*

1. Anterior lateral teeth.

There are two anterior laterals La I and La III, both of which are strongly opisthocline, but rather small and rudimentary; the ventral La I is, however, considerably stronger than the dorsal obsolete La III, separated from it by a deep broad socket.

2. Cardinal teeth.

The anterior cardinal tooth Ca3a is very small rudimentary, slightly opisthocline and joined with its apex to Ca3p; Ca 1 is strong, rather high and thorn-like, compressed in antero-posterior direction, slightly prosocline, having a narrow slit-like socket on its anterior and a long and broad socket on its posterior side; Ca3p is elongate and rather strong, prosocline, broad at the base, attenuated at the apex, encircling together with Ca3a, Ca 1; on its posterior side is a shallow, but rather broad socket and behind it the ligamental nymphe.

3. Posterior lateral teeth.

There are two almost imperceptible thin, but rather elongate, prosocline posterior laterals La I and La III, separated by a shallow socket.

b. *Left valve.*

1. Anterior lateral teeth.

The anterior lateral La II is very strong, transversely elongate, compressed in dorso-ventral direction, strongly opisthocline, having a shallow socket on its ventral and a deep one on its dorsal side.

2. Cardinal teeth.

The anterior cardinal tooth Ca2a is rather lamellar, slightly prosocline; its apex is strongly turned backwards and joined to Ca2p, there is a narrow socket on its anterior (dorsal) and a deep socket on its posterior (ventral) side. Ca2p is very strong and broad, rather high, and strongly prosocline, forming with Ca2a a peculiar $\wedge$ shaped composite tooth; on its posterior side is a deep and broad socket, and then follows the elongate but rather thin and strongly prosocline tooth Ca4p, which is well separated by a furrow from the ligamental nymphe.

3. Posterior lateral teeth.

There is a very rudimentary but rather long curved, prosocline posterior lateral La II having a shallow socket on either side.

The hinge formula is therefore as follows:—

$$\begin{array}{l|l|l|l}
\text{Right valve La (III) : I} & \text{Ca. } \overbrace{\text{3a : 1 : 3p}} \text{ :} & L & \text{Lp (I) : (III).} \\
\text{Left valve La II} & \text{Ca. : } \underbrace{\text{2a : 2p}} \text{ : 4p} & L & \text{Lp (II).}
\end{array}$$

5. Genus: DIONE, Gray.

By most authors *Dione* has not been considered as a full genus but as a subgenus of *Cytherea* only; whatever view one is inclined to take, it must be admitted

that though there is a great similarity in the composition of the hinge, there appear to exist certain features by which the hinge of *Dione* may be readily distinguished from that of *Cytherea*.

The composite tooth Ca 2a + Ca 2p in the left valve appears to have always a pointed apex, not flattened like the genera *Cytherea* or *Circe*, and if I am not very much mistaken its anterior component Ca2a is generally opisthocline in this genus, while it is apparently generally prosocline in *Cytherea* and *Circe*; if this observation should prove to be correct, it would form a good characteristic and distinctive feature of the genus *Dione*.

The posterior cardinal Ca4p may be present, or almost amalgamated to the ligamental nymphe; it still preserves, however, its individuality, and in this regard differs from the genus *Cytherea*, where it is either entirely missing or very rudimentary.

The hinge formula is as follows :—

Right valve	La. (III) : I	Ca. 3a : 1 : 3p :	*L*	Lp (III) : I.
Left valve	La. : II :	Ca. : $\underbrace{2a : 2p}$: 4p	*L*	Lp II.

DIONE PHILIPPINARUM, Hanl. Plate III, fig. 3—3a.

a. *Right valve.*

1. Anterior lateral teeth.

There are two opisthocline, short, granular teeth on either side of a deep, elongate socket, the ventral tooth LaI is somewhat larger than the minute dorsal one La III, which is close to the margin.

2. Cardinal teeth.

The anterior cardinal tooth Ca3a is short, very thin, lamellar, slightly opisthocline and joined with its apex to Ca3p; separated by a slit-like narrow socket is a somewhat larger and slightly prosocline Ca 1, inside the angle formed by Ca3a and Ca3p. On the posterior (dorsal) side of Ca3a is a deep socket, and behind it follows a large, elongate and strongly prosocline bifid tooth Ca3p; separated by a deep furrow from the ligamental nymphe.

3. Posterior lateral teeth.

There are two very thin, long, lamellar posterior laterals Lp I and Lp III, curved and strongly prosocline, separated by a shallow socket.

b. *Left valve.*

1. Anterior lateral teeth.

There is a strong, high, opisthocline, elongate anterior lateral La II, having a deep socket on its dorsal and a shallow one at its ventral side.

2. Cardinal teeth.

The anterior cardinal tooth Ca2a is thin, lamellar, opisthocline and joined with its apex to Ca2p; on both sides the anterior and posterior one of Ca2a there

are deep sockets; Ca2p is very strong, broad at its base, acuminated at its apex and strongly prosocline; together with Ca2a it forms an unsymmetrical, ∧ shaped tooth the apex of which is anteriorly inclined. Behind Ca2p is a long, narrow and deep socket, on the dorsal side of which there is a curved prosocline, thin elongate tooth Ca4p, close to the ligamental nymphe.

3. Posterior lateral teeth.

There is an elongate, thin, curved and prosocline tooth LaII, having a shallow socket on its ventral side.

The hinge formula is therefore:

Right valve	La. (III) : I	Ca. 3a : 1 : 3p :	*L*	Lp. (III) : (I).
Left valve	La. : II :	Ca. : 2a : 2p : 4p	*L*	Lp. (II) :

Remarks.—The above formula would repesent the general formula of the genus *Cytherea* with regard to the number and the arrangement of the cardinal teeth; it differs, however, with regard to the posterior laterals, of which there are a larger number, though in rudimentary state.

DIONE PROTOPHILIPPINARUM, Noetling. Plate III, fig. 4—4a.

a. *Right valve.*

1. Anterior lateral teeth.

The anterior laterals are very reduced in size; they are on either side of a deep, transversely elongate socket; the ventral one La I being the larger, the dorsal one La III much smaller and close to the anterior margin.

2. Cardinal teeth.

The anterior cardinal tooth Ca3a is thin, lamellar, rather longer than Ca 1 and slightly prosocline; it is separated by a thin slit-like socket on its posterior (ventral) side from a smaller thin lamellar Ca 1, which is just perceptibly prosocline; on its dorsal side is a broad and deep socket behind which there is a strong posterior cardinal Ca3p; it is broad at its base, attenuated towards the apex, strongly prosocline, the apex just touching Ca2a, and deeply bifid, a deep furrow separates it from the strong ligamental nymphe.

3. Posterior lateral teeth.

There are two thin, elongate, prosocline posterior laterals Lp I and Lp III separated by a long slit-like socket.

b. *Left valve.*

1. Anterior lateral teeth.

There is only one anterior lateral La II, which is slightly opisthocline and almost horizontal; it is strong, high, transversely elongate, having a deep socket on its dorsal side.

2. Cardinal teeth.

The anterior cardinal Ca2a is thin, lamellar and slightly prosocline, having on either side a deep socket; its apex is joined to Ca2p; Ca2p is broad at the base, attenuated towards the apex, and so strongly prosocline that it lies almost horizontally; together with Ca2a it forms an unsymmetrical ∧ shaped tooth, the apex of which is slightly anteriorly produced. On the dorsal side of Ca2p is a deep, broad socket, and behind it, almost entirely amalgamated to the ligamental nymphe, an elongate lamellar tooth Ca4p, which is curved and strongly prosocline.

3. Posterior lateral teeth.

There is only a very rudimentary elongate posterior lateral La II having a shallow socket on its ventral side.

The hinge formula is, therefore, as follows :

Right valve	La. (III) : I	Ca. 3a : 1 : 3p :	*L*	Lp (III) : (I).
Left valve	La. : II	Ca. : 2a : 2p : 4p	*L*	Lp (II) :

Remarks.—From the above description it will be seen that the hinge of the miocene species equals in all its chief constituents to that of the recent *Dione philippinarum*; in fact it is only on very close observation that some differences can be discovered, which however appear to be immaterial. The lunular tooth La II is apparently more horizontal in the miocene than in the recent species, and its distance from Ca2a is greater in the former than in the latter; Ca2a is apparently slightly prosocline in the fossil, and strongly opisthocline in the recent species; in *Dione protophilippinarum* the apex of the ∧ shaped tooth is therefore slightly more drawn in anterior direction than in *Dione philippinarum*; and while in the former Ca3p is deeply bifid, this feature is just indicated in the living species.

Dione arrakanensis, Noetling. Plate III, fig. 5.

a. *Right valve.*

No right valve of this species being known, the hinge characters could be only conjectured from an impression of the hinge of the left valve; as this, however, is insufficient for the finer study of details, particularly with regard to a comparison with other species, I refrain from any further conclusions, and I can only give the description in general outlines.

1. Anterior lateral teeth.

There are probably two rudimentary anterior laterals, La I and La III, the latter being the smaller.

2. Cardinal teeth.

There is a thin, lamellar anterior cardinal Ca3a, which was probably slightly opisthocline; Ca 1 was probably similar in shape to the former but slightly smaller; Ca3p is the largest, and strongly prosocline.

3. Posterior lateral teeth.

There were probably two posterior laterals Lp I and Lp III, both of which were certainly elongate, lamellar and very thin.

b. *Left valve.*

1. Anterior lateral teeth.

There is a transversely elongate, rather high, ventro-dorsally compressed anterior lateral tooth La II, which is strongly opisthocline and almost horizontal, having a deep socket on its dorsal side.

2. Cardinal teeth.

The anterior cardinal tooth Ca2a is thin, lamellar, slightly curved and opisthocline, having a deep socket on its anterior and posterior side ; at the apex it is joined to Ca2p. This tooth is broad at its base, attenuated at its apex, strongly prosocline, and joined to Ca2a, forming an unsymmetrical Λ shaped tooth, the apex of which is strongly drawn in anterior direction ; behind it is a deep, broad socket, which is followed by an elongate, curved and strongly prosocline tooth Ca4p, which is almost amalgamated to the ligamental nymphe.

3. Posterior lateral teeth.

There is only a rudimentary, elongate, curved posterior lateral La II.

The hinge formula is, therefore, as follows :—

Right valve La. (III) : I	Ca. 3a : 1 : 3p	*L*	Lp (III) : I.
Left valve La. II :	Ca. : 2a : 2p : 4p	*L*	Lp (II).

Remarks.—The composition of the hinge is exactly the same as that of *Dione subphilippinarum*, but all the elements are stronger, inclined in anterior direction, particularly the composite tooth Ca2a + Ca2p.

Dione amygdaloides, Noetling. Plate III, fig. 6.

a. *Right valve.*

As only the left valve is known, the hinge of the right valve had to be constructed from a cast of that of the left one ; its composition can, therefore, only be ascertained in a general meaning.

1. Anterior lateral teeth.

There are apparently two anterior laterals LaI and III, both of which are probably small, La III almost rudimentary

2. Cardinal teeth.

The anterior cardinal Ca3a was probably lamellar, thin, and slightly prosocline, having a slit-like socket on its posterior (ventral) side ; Ca 1 was similar in shape to the former, almost parallel to it, and therefore slightly prosocline ; behind it is a deep socket, and then follows a large, strongly prosocline Ca3p, of which it is impossible to say whether it was bifid or not ; in all probability this was the case.

Posterior lateral teeth.

It is very probable that there existed two elongate, but rudimentary posterior laterals Lp I and Lp III.

b. *Left valve.*

1. Anterior lateral teeth.

There is a strong, ventro-dorsally compressed, transversely elongate anterior lateral La II which is so strongly opisthocline that it lies almost horizontal; on its dorsal side is a deep socket.

2. Cardinal teeth.

The anterior cardinal tooth Ca2a is very thin, lamellar, strongly prosocline, with a deep socket at either side; its apex is joined to Ca2p; this tooth is very strong and broad at the base, attenuated towards the apex, strongly prosocline, forming with Ca2a, a Λ shaped unsymmetrical tooth the apex of which is strongly drawn in anterior direction. Behind it is a deep, broad socket, and then follows the lamellar, elongate and strongly curved and prosocline Ca4p, which is almost amalgamated to the ligamental nymphe.

3. Posterior lateral teeth.

There is a rudimentary elongate, curved and prosocline posterior lateral La II, having a shallow socket at its ventral side.

The hinge formula is, therefore, as follows :—

$$\begin{array}{l|l|c|l}
\text{Right valve La. (III) : I} & \text{Ca. 3a : 1 : 3p :} & L & \text{Lp (III) : (I).} \\
\text{Left valve La. II :} & \text{Ca. : } \underbrace{\text{2a : 2p}} \text{ : 4p} & L & \text{Lp (II) :}
\end{array}$$

Remarks.—The hinge formula differs in no way from that of the other species with regard to its elements and number of teeth; Ca2p seems, however, much stronger than the similar tooth of the other species, while Ca3a appears much more curved; the general appearance of the composite tooth Ca2a : + Ca2p differs therefore somewhat from that of other species, particularly because both its constituents form a larger angle.

6. Genus : DOSINIA, Scopoli.

Owing to rather insufficient material I am unable to fix with accuracy the differences which distinguish the hinge of this genus from those of the preceding genera; the hinge of the only species here described is readily enough distinguished, but I am unable to say how far the differences are specific or not.

It appears, however, that a chief feature are the very rudimentary anterior laterals in the right valve, the deeply notched posterior cardinal Ca3a, which connects it with the genera *Venus* and *Chamelæa*.

The hingle formula is as follows :—

Right valve	La. (III) : I	Ca. 3a : 1 : 3p :	L	Lp. (III) : I.
Left valve	La. II	Ca. : $\underbrace{2a : 2p}$: 4p(?)	L	Lp. (II).

DOSINIA PROTOJUVENILIS, Noetling. Plate III, fig. 7.

a. *Right valve.*

1. Anterior lateral teeth.

Both anterior laterals La I and La III are of the same size, very rudimentary, granular, strongly opisthocline and separated by a short shallow socket.

2. Cardinal teeth.

The anterior cardinal tooth Ca3a is close to the anterior margin, thin, lamellar and strongly opisthocline; it is separated by a narrow slit-like socket from Ca 1; this tooth is similar in shape to Ca3a, but a little smaller and almost parallel to it; on its posterior side is a deep socket, which is followed by a strong elongate, bifid tooth curved and prosocline; behind it is a narrow furrow separating it from the ligamental nymphe.

3. Posterior lateral teeth.

There are two thin lamellar posterior laterals LpI and LpIII, separated by rather a deep socket; both are rather long, and strongly prosocline.

b. *Left valve.*

No left valve is known, but from an impression of the hinge of the right valve its general composition can be judged with some accuracy.

1. Anterior lateral teeth.

There is only one lateral tooth La II close to the anterior margin, most probably it was very small but still stronger than the teeth of the right valve, compressed in dorso-ventral direction and opisthocline.

2. Cardinal teeth.

The anterior cardinal tooth Ca2a must have been very thin, lamellar and opisthocline, having a deep socket on either side; it is very probable that it was joined with its apex to Ca2p; this tooth was apparently rather strong, broad at the base, attenuated towards the apex, and strongly prosocline, forming most probably a $\wedge$ shaped unsymmetrical tooth with Ca2a, the apex of which was not anteriorly drawn; on the dorsal side of Ca2p was a deep socket and behind probably a thin, elongate and lamellar Ca4p, which was curved and strongly prosocline, rudimentary and almost amalgamated to the ligamental nymphe.

3. Posterior lateral teeth.

There was probably only a single posterior lateral Lp II of thin elongate shape, curved and strongly prosocline.

The hinge formula is therefore —

$$\begin{array}{lllll} \text{Right valve La. (III)} & : \text{I} & \Big| \text{ Ca. 3a} : 1 : 3\text{p} : & \Big| \; L \text{ Lp. (III)} : \text{(I).} \\ \text{Left valve La.} & \text{II} & \Big| \text{ Ca.} : \underbrace{2\text{a} : 2\text{p}} : (4\text{p}) & \Big| \; L \text{ Lp.} \quad \text{(II).} \end{array}$$

Remarks.—The above hinge represents the true hinge of *Venerinæ*, and is chiefly distinguished from that of *Dione* or *Cytherea* by a very weak LaII, and by the closely set parallel Ca3a and Ca 1 which appear to be almost parallel to the ventro-dorsal axis.

Subfamily: TAPETINÆ, Fischer.

7. Genus: TAPES, Megerle.

The hinge of Tapes affords an exceedingly good illustration of the eventual development of the deeply notched cardinals; we have seen that in the genus *Chamelœa* the two cardinals Ca2p and Ca3p were deeply notched, while just an indication of a notch was noticeable on Ca 1; in the genus *Venus* this tooth was also deeply notched, Ca2p and Ca3p being notched as in *Chamelœa*, but in *Tapes* the notching has been carried to such an extent that Ca3p, but particularly Ca2p, afford the appearance of two separate teeth; the appearance of both valves, in special that of the left valve, where Ca2p is divided into two branches separated by a broad and deep socket, might lead one to believe that the hinge consisted of 4 cardinals instead of 3, but on closer examination it will be seen that the sockets which divide Ca2p and Ca3p are pseudo-sockets only, there being no tooth in the opposite valve to be fitted into them. On the other hand, this feature affords a valuable hint as to the further evolution of the hinge of the bivalves; if ever a Ca1p should develop from the primary lamella LA I, this tooth would certainly be interlocked between the two branches Ca2pα and Ca2pβ of the posterior cardinal Ca2p.

The anterior laterals are entirely missing and the posterior laterals are so extremely rudimentary that they are hardly observable; on the whole the hinge of *Tapes* is closer related. That of *Venus* and to that of its allied genera; the hinge formula is as follows:—

$$\begin{array}{llll} \text{Right valve La O} & \Big| \text{ Ca. 3a} : \overbrace{1 : 3\text{p}}^{3\text{p}\alpha + 3\text{p}\beta} & \Big| \; L & \Big| \text{ La.} : \text{(I).} \\ \text{Left valve La O} & \Big| \text{ Ca.} : \underbrace{2\text{a} : 2\text{p}}_{2\text{p}\alpha + 2\text{p}\beta} : & \Big| \; L & \text{ La. (II).} \end{array}$$

TAPES ADSPERSA, Linne Plate II, fig. 6—6a.

a. *Right valve.*

1. Anterior lateral teeth.

No trace could be discovered of the anterior laterals, which are therefore missing.

2. Cardinal teeth.

The anterior cardinal Ca3a is rather short, thin, lamellar, compressed in antero-posterior direction, just perceptibly opisthocline; on its posterior (ventral) side is a deep but narrow socket and behind it Ca 1; this tooth is slightly prosocline, lamellar, compressed in antero-posterior direction, and deeply notched; behind it is a broad and deep socket, and then follows the elongate lamellar and strongly prosocline tooth Ca3p, which is divided by a deep but narrow pseudo-socket into two branches Ca3pα and Ca3pβ, the latter of which is slightly lower but somewhat longer than the former, and separated by a deep but narrow furrow from the strong elongate ligamental nymphe.

3. Posterior lateral teeth.

There is one exceedingly thin but elongate prosocline ridge behind the ligament, which is so rudimentary that it can hardly be considered as a tooth, but having a shallow socket on its dorsal side it represents obviously La I.

b. *Left valve.*

1. Anterior lateral teeth.

No trace could be discovered of the anterior laterals, which are therefore missing.

2. Cardinal teeth.

The anterior cardinal Ca2a is short, thin, compressed in antero-posterior direction, slightly opisthocline, having a deep socket on either side; then follows a thin, lamellar prosocline tooth and separated by a broad and deep pseudo-socket another similar but somewhat larger tooth; at the first instance one might be led to believe that the anterior tooth represents Ca2p and the posterior one Ca4p, but if both valves are closed it will be seen that no tooth interlocks between them, but that, on the other hand, both are interlocked between Ca 1 and Ca3a; both teeth represent, therefore, Ca2p, and the branches might be distinguished as Ca2pα and Ca2pβ. Behind it follows a deep socket and on the dorsal side of this, and almost amalgamated to the ligamental socket, is the rudimentary, strongly prosocline Ca4p.

3. Posterior lateral teeth.

There is a thin prosocline elongate ridge close to the margin which may be considered as Lp II.

The hinge formula is therefore:

$$\begin{array}{ll|l|c|l}
\text{Right valve} & \text{La. O} & \text{Ca 3a} : 1 : \overbrace{\text{3p}}^{3p\alpha \div 3p\beta} & L & \text{Lp.} : \text{(I).} \\
\text{Left valve} & \text{La. O} & \text{Ca} : \text{2a} : \underbrace{\text{2p} :}_{2p\alpha \div 2p\beta} & L & \text{Lp. (II).}
\end{array}$$

Genus CYRENA, Lamarck.

According to Bernard the hinge formula of this genus is—

$$\begin{array}{ll|l|c|l}
\text{Right valve} & \text{La. (III)} : \text{I} & \text{Ca. 3a} : 1 : \text{3p} : & L & \text{Lp. III} : \\
\text{Left valve} & \text{La. II} & \text{Ca.} : \text{2a} : \text{2p} : \text{4p} & L & \text{Lp. II} :
\end{array},$$

I have examined the hinge of three species: the living *Cyrena galatheæ* from the Nicobar islands and two fossil ones *Cyrena crawfurdi*, Noetl., and *Cyrena petrolei*, Noetl., which occur in a bed terminating the miocene formation at Yenangyoung.

The two fossil species have not exhibited any material difference from the hinge of the living species, and the general formula is, therefore, exactly the same in all three, the only features by which the hinge of *Cyrena crawfurdi* differs from that of *Cyrena galatheæ* are connected with the lateral teeth. So far I have not discovered any transverse striae either on the sockets or teeth of the living species; I am, however, unable to say whether they are really missing or not, as I had only a single species for comparison.

The chief difference consists in the size; in both fossil species the posterior and anterior laterals are much longer than in the living species, as the following measurements will demonstrate:—

	Length of shell.	Length of La II.	Length of Lp II.
Cyrena galatheæ . . .	104 mm.	19·0 mm.	15·0 mm.
Cyrena crawfurdi . . .	40 „	13·0 „	15·0 „

The difference will be more obvious of the length of the laterals is expressed in parts of the length of the shell it is in—

	La II.	Lp II.
Cyrena galatheæ	0·18	0·13
Cyrena crawfurdi	0·32	0·37

We see, therefore, that in the living species the length of the anterior lateral La II is only one-fifth of the length of the shell, while it is nearly one-third of it in the miocene species; with regard to the posterior lateral Lp II it is only one-seventh of the whole length in *Cyrena galatheæ*, while it is a little over one-third in *Cyrena crawfurdi*; or with other words, if the same ratio existed between the length of the laterals in the living as in the fossil species, the anterior lateral ought to be 33·28 mm. and the posterior lateral 38·48 mm. in length.

I am not in the position to say whether this difference is only a specific one or whether it is an evolutionary feature; if it would be proved that the fossil *Cyrenæ* had generally longer laterals, the conclusion that the tendency in the evolution of the hinge of the *Cyrenæ* was towards the reduction of the length of the laterals would certainly be justified.

This view seems to find some support by the figures of *Cyrena venulina*, Dkr., from the Wealden, exhibiting some very long laterals; as however the generic determination of these so-called *Cyrenæ* may be questioned, the inference may not be considered of much value. Dunker's figures, particularly fig. 11c., show distinctly two cardinals only; in fact Dunker states himself that the hinge consists of two cardinals in each valve only; these cardinals are unquestionably Ca3a and Ca3p in the right and Ca2a and Ca2p in the left valve; the hinge of the Wealden *Cyrena* would therefore be distinguished by the absence of Ca 1, a feature which is so characteristic that it would be impossible to include these species in a genus which exhibits such

an unquestionably modern hinge as *Cyrena*. I have unfortunately no material to follow up this question, but it seems very probable that the modern and tertiary *Cyrenæ* have been evolved from the Wealden species by the development of Ca 1. I am unfortunately unable to decide whether Dunker's statement with regard to *Cyrena recurvata*, Val., from the Philippine Islands is correct; but adopting its correctness it is not yet proved that the two cardinal teeth which this species is said to possess are homologous to those of the Wealden species; in fact it seems to me more probable that the hinge of *Cyrena recurvata* exhibits a number of teeth reduced by atrophy of some teeth with higher indices, always provided that it consists of two teeth only. With all outward similarity the hinge of the Wealden *Cyrenæ* would, therefore, not be homologous to that of *Cyrena recurvata* unless it be proved that the hinge of this species consists of Ca3a, Ca3p and Ca2p, as as in the Wealden species.

CYRENA GALATHEÆ, Mörch. Plate IV, fig. 2—2a.

a. *Right valve.*

1. Anterior lateral teeth.

There are two anterior lateral teeth, LaI and LaIII, the ventral LaI is elongate, strong and thick opisthocline and separated by a rather short but very deep socket from the low rudimentary La III.

2. Cardinal teeth.

The anterior cardinal Ca3a is rather short, knob-like and slightly opisthocline; on its posterior (dorsal) side is a deep socket followed by a stout slightly prosocline tooth Ca1; this tooth is rather thick, only slightly tapering towards the apex; on its posterior (dorsal) side there is a deep socket, followed by the rather long, strongly prosocline Ca3p, which is moderately attenuated towards the apex; on its dorsal side is a deep socket; then follows the strong, broad ligamental nymphe.

3. Posterior lateral teeth.

There are two posterior lateral teeth La I and La III; which both are longer than the corresponding anterior laterals, the ventral La I is rather long and thick, strongly prosocline, separated by a deep elongate socket from a rudimentary prosocline La III.

b. *Left valve.*

1. Anterior lateral teeth.

There is a very thick, elongate strongly opisthocline anterior lateral La II, having on its dorsal side a shallow socket.

2. Cardinal teeth.

The anterior cardinal tooth Ca2a is short but rather broad, just perceptibly prosocline, having a shallow socket on its anterior (dorsal) and a broad deep socket on its posterior (ventral) side; Ca2p is slightly longer, strongly prosocline, broad

at the base and hardly attenuated towards the apex, behind it is a deep socket, and then follows the almost rudimentary low and thin strongly prosocline Ca4p; behind it is the broad ligamental nymphe.

3. Posterior lateral teeth.

There is only one rather strong, elongate and prosocline posterior lateral tooth La II, which is of the same length or perhaps slightly longer than the corresponding anterior lateral, having a shallow socket at its dorsal side.

The hinge formula is, therefore, as follows :—

Right valve	La. III : I	Ca. 3a : 1 : 3p :	*L*	Lp. III : I.
Left valve	La. II	Ca. : 2a : 2p : 4p	*L*	Lp. II.

CYRENA CRAWFURDI, Noetling. Plate IV, fig. 1—1a.

a. *Right valve.*

1. Anterior lateral teeth.

There are two anterior laterals La I and La III, both elongate and strongly opisthocline; the ventral La I is considerably stronger and thicker than the dorsal La III; both are separated by an elongate socket, which is broad and deep at its posterior part, but suddenly constricts to a narrow furrow; the ventral side of the socket is covered with numerous fine transverse parallel plications.

2. Cardinal teeth.

The anterior cardinal Ca3a is very short, knob-like, perhaps slightly opisthocline; on its posterior side is a broad and deep socket, which is followed by the short thick slightly prosocline Ca 1; on its posterior side is a broad and deep socket, followed by the elongate but rather thin strongly prosocline Ca3p, which has on its posterior side a long and deep socket. Then follows the broad ligamental nymphe.

3. Posterior lateral teeth.

There are two posterior laterals, the ventral one of which, Lp I, is rather long, thick and strongly prosocline; Lp III is almost rudimentary and separated from the former by a very elongate socket, which is broad at its anterior end, but narrows gradually in posterior direction; the ventral side of the socket is covered with numerous fine transverse plications.

b. *Left valve.*

1. Anterior lateral teeth.

There is one elongate, strongly opisthocline anterior lateral La II, which is rather thick at its posterior but very thin at its anterior extremity: its dorsal side is covered with fine transverse plications; there is a shallow socket on either side.

2. Cardinal teeth.

The anterior cardinal Ca2a is rather short, opisthocline, having a shallow socket on its anterior, and a broad and deep socket at its posterior side; then follows the strongly prosocline stout Ca2p, which has a broad and deep socket on its posterior (dorsal) side; this is followed by a thin, low, elongate, strongly prosocline Ca4p on the edge of the ligamental nymphe.

3. Posterior lateral teeth.

There is one elongate, strongly prosocline posterior lateral, which is broad and thick at its anterior, thin and lamellar at its posterior end; having its dorsal side covered with fine transverse plications; there is a deep socket on its dorsal and a shallow one on its ventral side.

The hinge formula is, therefore, as follows :—

Right valve	La. (III) : I	Ca. 3a : 1 : 3p :	*L*	Lp. (III) : I.
Left valve	La. II	Ca. : 2a : 2p : 4p	*L*	Lp. II.

Genus : MACTRA, Linné.

In the genera and families hitherto described there is an unquestionable tendency towards the reduction of the lateral, and the development of cardinal teeth; in the genus *Mactra* apparently the opposite takes place; the laterals increase considerably in length and strength at the expense of the cardinals, which become almost entirely obsolete. I am unfortunately not in the position to support this statement by more extensive observations, but the instance which the comparison of the hinge of the recent *Mactra laevis* and that of the miocene *Mactra protoreevesi* afford is so striking that the theory of a certain group of Bivalves, including such genera as *Mactra*, *Corbula*, and perhaps the whole order of *Desmodonta*, Neumayr, in which the increase in strength of the laterals takes place at the expense of the strength of the cardinals, while the reverse happens in the *Heterodonta*, is by no means improbable.

Of course further investigations are required to prove the correctness of the above view, which would afford a good systematical feature.

According to Bernard the hinge formula of *Mactra* is as follows :—

Right valve	La. III : I	Ca. 3a : 0^1 : 3b	*L*	Lp. III : I,
Left valve	La. II	Ca. 2a : 2b : 4b	*L*	Lp. II.

The examination of the two species above referred to has, however, revealed some curious features, which I am unable to explain unless the hinge formula is considerably changed. I am however not in the same position as Mr. Bernard, who was able to follow up the development of hinge of *Mactra*, and I may be mistaken, but both the hinges of the recent *Mactra laevis* and the miocene *Mactra protoreevesi* exhibit very peculiar features with regard to the anterior laterals.

There are in the left valve two anterior laterals, which unquestionably represent La II and La IV; their arrangement is, however, such that unless their development is known some doubt may be attached as to their identification; the anterior one of these teeth is in both species larger than the posterior one and fits in the socket between the two large anterior laterals of the right valve; the most plausible interpretation would therefore be to consider it as La II, and therefore the two anterior laterals in the right valve as La I and La III.

In this case the tooth behind La II, *i.e.*, on its ventral side, could not be considered as a lateral, but would have to be considered as a cardinal, and should then logically represent Ca4a; as it is however unquestionably on the ventral side of Ca3a when the valves are closed, it cannot possibly represent Ca4a; in fact it cannot represent a cardinal tooth at all.

By careful examination of the hinge of the living *Mactra laevis* I discovered that the posterior extremity of the large anterior lateral continued on the dorsal side of the smaller tooth, and being cemented to it, a faint furrow only marks the boundary between the two; it is therefore unquestionable that the smaller tooth is on the ventral side of the large one, is a lateral and must represent La II, while the large anterior tooth represents La IV; the logical consequence is therefore that the two anterior laterals of the right valve must represent La III and La V.

This view is further supported by an observation in the right valve; there is a small though rather high lamellar tooth in front of Ca3a, which might at first sight be considered as a detached part of that tooth, but on closer examination it will be found that it is distinctly on its ventral side, as well as on the ventral side of the ventral of the anterior laterals, and when both valves are closed it will be seen that this tooth is on the ventral side of the tooth which must represent La II; the logical consequence is therefore that it represents La I, and then of course the other two laterals must represent La III and La V.

The examination of the hinge of the miocene *Mactra protoreevesi* showed distinctly that the posterior of the two foremost teeth of the left valve is actually on the ventral side of the most anterior tooth, and that therefore the latter must necessarily have a higher index than the former, and if the first tooth is considered as a lateral, it can only represent La IV while the second one represents La II.

The examination of both species has therefore led to the same result, *viz.*, the large anterior lateral of the left valve must represent La IV and the two large anterior laterals of the right valve therefore La III and La V. The hinge formula would therefore be.—

$$\begin{array}{l|l|c|l}
\text{Right valve La. V : III : (I)} & \text{Ca. } \overbrace{(3a) : 0^1 : 3p} & L & \text{Lp. III : I.} \\
\text{Left valve La. IV : II} & \text{Ca. } \underbrace{2a : 2p} : (4p) & L & \text{Lp. II.}
\end{array}$$

If this formula be compared to that of Mr. Bernard it will be seen that the difference consists not only in the assumption of one more anterior lateral

La V, but chiefly in the different interpretation of the anterior laterals, which will be best seen from the following table :—

Left valve.			Right valve.		
Noetling.		Bernard.	Noetling.		Bernard.
La II.		Not mentioned.	La I.		Not mentioned.
La IV.	=	La II.	La III.	=	La I.
			La V.	=	La III.

It may certainly be argued that the above view suffers from the great disadvantage of being deduced, and not supported by actual observation, while Mr. Bernard's interpretation of the hinge is based on actual observation of the development ; but quite apart from the fact that it is impossible to reconcile the features of the hinges of *Mactra laevis* and *Mactra protoreevesi* with Bernard's opinion, I cannot quite suppress the notion that the figures as given by that author are suggestive of another interpretation ; fig. 23-2 as well as fig. 23-3 seem to indicate that the ventral anterior lateral which is interpreted as La I is actually the continuation of the primary lamella from which the two cardinals Ca3a and Ca3p originated ; if this view be correct, the lateral on the dorsal side of it must necessarily be La V.

The hinge of *Mactra* as interpreted by me would therefore be distinguished by the large number of anterior laterals, of which the older ones La III, La IV and La V are still strongly developed, while the younger La II and particularly La I are in an imperfect state ; that La I is apparently a recent acquisition seems to be proved by its absence in the miocene *Mactra protoreevesi* ; further examinations would, however, be required to say anything definite in this regard, as the living *Mactra solida* seems also lacking of La I.

The above view is quite in harmony with the theory here promulgated that the appearance of the primary lamella La I is a modern feature, while its absence and the presence of teeth with a higher index indicate a more archaic type.

The hinge of *Mactra*, with its strongly developed laterals of a higher order, its more or less rudimentary cardinals, distinguished by the missing Ca1, and if present a very rudimentary La I, together with its internal ligamental socket, would therefore represent an eminently archaic type. This theory is of course quite in disharmony with the generally accepted one, that *Mactra* is a modern type ; I should however not be very much surprised if, when fully preserved shells of species which have hitherto been ranged under the genera *Astarte*, *Venus*, but particularly *Cyprina*, could be examined, most of them would turn out to belong to the genus *Mactra*. In confirmation of the above I may already be permitted to say that species like *Astarte hyderabadensis*, d'Archiac and Haime, *Venus nonscripta*, Sowerby, and *Venus hyderabadensis*, d'Archiac and Haime, from the Tertiary of Western India really belong to the genus *Mactra*.

MACTRA LAEVIS, Linné. Plate IV, fig. 4—4a[1].

a. *Right valve.*

1. Anterior lateral teeth.

There are three opisthocline anterior laterals La I, La III and La V, two of which, La III and La V, are very long but rather thin, being compressed in ventro-dorsal direction; both are rather high, pointed at their anterior extremity but rapidly decrease in posterior direction; both are slightly curved in dorsal direction at their anterior end, and La III is considerably weaker than La V; the socket separating both is deep, broad at the anterior extremity, but narrows strongly in posterior direction; Lp V is well set off from the margin by a deep furrow. The tooth which I consider as La I is an almost rudimentary, short but rather high lamella, in front of Ca3a, and on the ventral side of La III.

2. Cardinal teeth.

The cardinal teeth have become so extremely rudimentary that they are hardly recognizable, and the ∧ shaped tooth formed by the union of Ca3a and Ca3p is hardly recognizable; Ca3a is a weak, thin, opisthocline lamella, having a deep socket at its posterior side, Ca3p is almost reduced to a short prosocline fragment at the anterior side of the large ligamental groove.

3. Posterior lateral teeth.

There are two posterior laterals LpI and LpIII, both strongly prosocline, rather long, but thin lamellar, the dorsal Lp III being the weaker; both are high, pointed at the posterior end, and rapidly decrease in height in anterior direction; the socket separating them is narrow, slit-like at its anterior end, but broadly widens out in posterior direction.

b. *Left valve.*

1. Anterior lateral teeth.

There are two anterior laterals La II and La IV, though the peculiar appearance of these teeth renders their identification exceedingly difficult; the most anterior tooth is opisthocline, rather long, lamellar, high and pointed at its posterior extremity, becoming abruptly lower at its anterior one and having a deep socket at its dorsal side; this tooth fits into the socket between the two corresponding teeth of the right valve, and if we assume these to be La I and La III, this tooth should represent La II; there is however a difficulty; immediately behind this tooth, and unquestionably at its ventral side, there is another smaller opisthocline lamellar tooth, which cannot be identified if we assume the anterior tooth to be La II; the only possibility is that the former represents La IV and the latter La II; in this case the two anterior laterals of the right valve must necessarily represent La III and La V.

When both valves are interlocked, the tooth La II is on the dorsal side of a rudimentary lamella in the right valve which I interpreted as La I; the tooth

[1] By a mistake an unfortunate error has occurred in the denomination of the teeth of fig. 4a—
Ca3a should be denominated La I.
La I " " Ca3a.

considered to be La II is therefore unquestionably at the ventral side of the large La III, although this cannot well be seen when the valves are closed.

2. Cardinal teeth.

The anterior cardinal Ca2a is almost the continuation of La II; rather high, lamellar and opisthocline, having a short but deep socket at its anterior, and a similar one at its posterior side; Ca2p is prosocline, very rudimentary, joined with its apex to Ca2a forming an obsolete ∧ shaped tooth, the posterior side of which is almost effaced.

3. Posterior lateral teeth.

There is a strong, elongate, lamellar posterior lateral La II which is strongly prosocline, high and pointed at its posterior end, decreasing in height towards its anterior extremity; at its dorsal side is a deep broad socket.

The hinge formula is therefore —

Right valve	La. V	: III	: (I)	Ca.	3a	: 0[1]	: 3p		*L*	Lp.	III	:	I.
Left valve	La.	: IV	: II	:	Ca.	: 2a	: 2p	:	*L*	Lp.	·	II.	

Mactra protoreevesi, Noetling. Plate IV, fig. 3—3a.[1]

a. *Right valve.*

1. Anterior lateral teeth.

There are two long, thin, lamellar, strongly opisthocline anterior laterals, La III and La V; the ventral La III is much longer and stronger than La V, being raised at its middle into a high knob. The dorsal tooth La V is very thin, a little undulating, high at its anterior, low at its posterior end, but shorter than La III, being separated by a deep elongate socket from it; it is well set off against the margin by a deep furrow.

2. Cardinal teeth.

The anterior cardinal Ca3a is thin, lamellar, strongly opisthocline, having a deep socket at its posterior (ventral) side; it is joined at its apex to Ca3p; the latter tooth is thin, lamellar, strongly prosocline, forming a ∧ shaped composite tooth with Ca3a, the apex of which is right underneath the umbo; behind it follows the deep internal ligamental socket.

3. Posterior lateral teeth.

There are two posterior lateral teeth La III and La I; both are thin, lamellar, elongate and strongly prosocline, the ventral La I is much stronger than the dorsal La III, separated from it by a deep narrow socket; both teeth are highest at their anterior extremity and decrease in posterior direction. Lp III is shorter, thinner and well set off from the margin.

b. *Left valve.*

1. Anterior lateral teeth.

[1] The anterior laterals of fig. 3a are erroneously designated.
La III. should be La V.
La I. " " La III.

At first sight it seems as if there was only one lamellar, thin, opisthocline anterior lateral, well set off from the margin by a deep furrow, and well forward of the umbo; under ordinary circumstances one would have unhesitatingly interpreted it as La II, but it is unquestionably on the dorsal side of La III when the valves are closed, and must, therefore, represent La IV. On its posterior, ventral side, separated by a shallow socket, there is a thin, lamellar and strongly opisthocline tooth which might be considered as a cardinal; on closer examination it will, however, be seen that the anterior continuation of this tooth passes on the ventral side of La IV; although becoming very rudimentary; it must, therefore, unquestionably represent the true La II which imitates shape and position of an anterior cardinal tooth.

2. Cardinal teeth.

The anterior cardinal tooth Ca2a is very thin, lamellar, strongly opisthocline, having a narrow socket on its anterior (dorsal) and a broad triangular socket on its posterior (ventral) side; its apex is joined to Ca2p; this tooth is very thin, lamellar, strongly prosocline and joined to Ca2p forming a ∧ shaped composite tooth, the apex of which is right underneath the umbo; behind it is the triangular ligamental socket.

3. Posterior lateral teeth.

There is only one large, lamellar, strongly prosocline tooth Ca II, having a rather broad socket on its dorsal side.

The hinge formula is, therefore, as follows :—

Right valve La. V : III :	Ca. 3a : 0^1 : 3p	*L*	Lp. III : I.
Right valve La. : IV : II	Ca. : 2a : 2p :	*L*	Lp. II.

Remarks.—It will be seen that the hinge of *Mactra protoreevesi* differs from that of the living *Mactra laevis* by the absence of the anterior lateral La I, but chiefly by the well developed and less rudimentary cardinal teeth in both valves.

I cannot help thinking that this hinge represents a more archaic type of the *Mactra* hinge by the absence of La I and the well developed cardinals, as we have seen that in the living species there is apparently a tendency towards the development of the former and a reduction of the latter.

Genus: MEIOCARDIA, H. & A. Adams.

The brothers Adams have separated under the name of *Meiocardia* a small group of shells which had been formerly included in the genus *Isocardia*. This separation seems not to have been generally acknowledged, though I think this to be a mistake. *Meiocardia*, of which *Meiocardia vulgaris* from the Indian Ocean and Chinese Seas may be considered as the type, includes very characteristic species which by their trapezoidal or triangular shape, but particularly by the sharp keel running from the umbo towards the posterior corner, markedly differ from the

globular rounded shell of *Isocardia*, and as we shall presently see the hinge of both groups is also different, a generic separation seems to be justified.

The species separated under the name of *Meiocardia* would exclusively inhabit the Indian Ocean and Chinese Seas, while *Isocardia* would be restricted to the Northern Seas.

It seems that *Meiocardia* though at present restricted to three species only, the specific difference of which may even be questioned, had a wide distribution throughout the Tertiary period, and it is even probable that it occurs in the cretaceous formation, as some species included in the genus *Trapezium* may perhaps belong to *Meiocardia*.

According to Bernard the hinge formula of *Meiocardia lamarki* is as follows :—

Right valve	La. III : I	Ca. 3a : 1 : 3p :	*L*	Lp. III : I
Left valve	La. II	Ca. 2a : 2p : 4p	*L*	Lp. II

I regret, however, to say that this formula does not appear to be quite correct, a view which is supported by Bernard's own figure. Bernard assumes that the lower (anterior-ventral) branch of the lamellar tooth following behind that he assumes to be Ca1, represents Ca2a. In this view I cannot however agree with him, as in normal cases an anterior cardinal cannot be prosocline, nor can it appear behind Ca1; it must therefore represent a posterior cardinal, *viz.*, Ca3p; this view is corrorborated by the study of the hinge of *Meiocardia vulgaris* as well as by Bernard's own figure; if we suppose that the figures of both valves as depicted by Bernard were put together, that tooth which he describes as Ca3a of the right valve would be on the *dorsal* side of that tooth which he supposes to be Ca2p of the left valve, and therefore one of the formulas, either that of the right or that of the left valve, must be wrong.

I have convinced myself from the study of the hinge of the living *Meiocardia vulgaris* that the ventral posterior tooth of the left valve lies on the ventral side of that of the right valve, where it fits into a narrow longitudinal socket.

The tooth of the right valve supposed to be by Bernard Ca3a can under these circumstances not represent that tooth, but must be Ca3p; in the above formula Ca3a would therefore disappear and be represented by Ca3p, while Ca3p, would become Ca5p.

There are, however, probably some other modifications; the study of the hinge of the living species has proved that the anterior angular tooth of both the right and the left valve is of a very complex nature. In the right valve it is composed of a posteriorly inclined longer posterior branch and a horizontal branch which is deeply notched and appears to be composed of two elements, which should be interpreted as Ca3a and La I.

It is obvious that this requires a trifid anterior tooth in the left valve, the posterior branch of which must be the longest, and being on the dorsal or anterior side of Ca 1 it must represent Ca2a. The interpretation of the granular tooth which, when both valves are closed, rests on the dorsal side of Ca2a, must therefore be correct; the

two anterior granules would then represent La II and La IV, and as La III fits between them this interpretation should be correct. The hinge formula of *Meiocardia* would therefore be—

Right valve	La. (III)	: I	Ca. (3a) :	1	: 3p	: 5p	*L*	Lp. III	: I.
Left valve	La. (IV)	: (II)	Ca.	2a	: 2p	: 4p	*L*	Lp.	II.

The anterior laterals IV, III, II and the posterior lateral III are rudimentary, while in the right valve La I, Ca3a, Ca 1 are amalgamated to form an angular tooth, and in the left valve La IV, La II, Ca2a form in a similar way a trifid tooth. According to Bernard *Isocardia cor* differs by the entire absence of the anterior lateral while from the posterior ones only II and III remain, a statement which I am unable to check, but which would be sufficient to prove that the specific difference of *Meiocardia* and *Isocardia* would also be justified by a difference in the composition of the hinge.

The miocene of Burma has yielded two species of this genus: *Meiocardia protovulgaris*, Noetl., and *Meiocardia metavulgaris*, Noetl., of which however only the hinge of the former is known.

A comparison with the hinge of the recent *Meiocardia vulgaris* from the Indian Ocean has proved that there is absolutely no difference with regard to the fundamental elements of the hinge of both the lower miocene and the recent species; the difference is purely formal, inasmuch as the cardinal margin of *Meiocardia protovulgaris* is stronger curved than that of *Meiocardia vulgaris*; the elements of the hinge are, therefore, arranged on a sharper curve on the former and on a flatter curve on the latter species. In other words the hinge of *Meiocardia vulgaris* is a little more stretched in antero-posterior direction than that of *Meiocardia protovulgaris*.

The hinge of *Meiocardia* differs from all those hitherto described by a remarkably less differentiated state; we find in both valves a curious angular tooth which is composed of probably at least three teeth; but inasmuch as most probably teeth resulting from two different primary lamellæ, *viz.*, La I and La III in the right, and La II and La IV in the left valve, participate in the formation of this composite tooth, it is obvious that it cannot be considered as a primitive tooth which has not become differentiated yet, but a secondary tooth resulting from the amalgamation of teeth which were originally separated. Ca3p and Ca5p, which form another composite tooth, were originally separate, and the question now arises, is this amalgamation of primarily separate teeth only a special sort of evolution, or a sign of degeneration, in other words a geratologic feature? Is it probable that the production of composite teeth in which almost all the traces of the original teeth are lost, is a geratologic feature which would correspond to, say, evolute ammonite shells? The question is an exceedingly interesting one, but further researches with regard to the development of hinges of the *Meiocardian* type are required, and I should think that the study of the hinge of

Isocardia, which is not so difficult to obtain, should lead to some definite views in this regard.

MEIOCARDIA VULGARIS, Reeve. Plate IV, fig. 5—5a.

a. *Right valve.*

Close to the anterior margin, perhaps a little behind the umbo, there is an angular tooth, having its apex turned in ventral direction ; its anterior side is almost horizontal, while the posterior side is opisthocline. On the dorsal (anterior) side of this tooth is a deep triangular socket followed by a small granule-like tooth. The interpretation of this tooth without knowing its evolution seems difficult, and I follow, therefore, Bernard, who regards the turned-up posterior side of the tooth as Ca 1 and the horizontal anterior side as La I, both of which are joined together. I wish however to remark that in the specimen under examination the anterior side of the angular tooth is curiously notched, thus making it appear as being composed of two elements. If this supposition be right, that part of the horizontal side which is next to Ca 1 should be considered as Ca3a ; the angular tooth would, therefore, result from the amalgamation of La I, Ca3a and Ca 1. The granular tooth is considered as La III.

Separated by a short but deep notch, follows a curved, lamellar and prosocline tooth which is sub-divided by a sharp furrow in a larger anterior and a shorter posterior tooth ; Bernard considers the anterior part as Ca3a and the posterior as Ca3p ; I would, however, feel inclined to put another interpretation and consider them rather as Ca3p and Ca5p, respectively.

Behind this tooth follows the ligament, and the posterior laterals of which Lp I is very long, lamellar, separated by a deep socket from an almost rudimentary, lamellar Lp III.

b. *Left valve.*

There is a rather large trifid tooth quite close to the anterior margin a little behind the umbo ; the anterior parts are small, granular, divided by a deep notch ; the posterior part is lamellar, much longer and opisthocline. Bernard considers the posterior longer branch as Ca2a and the anterior as La II*; the division of the anterior portion seems however to indicate that it is composed of two elements, La II and La IV.

Separated by a short notch follows a lamellar, curved and prosocline tooth Ca2p, separated by a narrow elongate furrow on its dorsal posterior side from a similar tooth Ca4p. Then follows the ligament and behind it a strong lamellar tooth LpII, having a rather deep socket on its dorsal side. The hinge formula would therefore be :—

Right valve La.	(III) : I	Ca. (3a)	: 1	: 3p	: 5p	*L*	Lp. III	: I
Left valve La.	(IV) : II	Ca.	: 2a	: 2p	: 4p	*L*	Lp.	II

Erroneously described as Lp.II.

MEIOCARDIA PROTOVULGARIS, Noetling. Plate IV, fig. 6—6a.

a. *Right valve.*

There is rather a large, angular tooth the posterior end of which is turned upwards so as to form an obtuse angle, the apex of which is turned ventrally, slightly in front of the umbo and close to the anterior margin. The anterior side is a little longer and slightly notched; on the anterior (dorsal) side is a deep triangular socket, followed by a minute granular tooth close to the margin; a comparison with the recent *Meiocardia vulgaris* proves that the same elements are developed as in that species and that the posterior side of the angular tooth represents La I; the anterior horizontal branch is composed of Ca3a and Ca 1, while the granular tooth on the dorsal end of the socket represents La III. The only difference noticed would be, that in the miocene species Ca 1 is shorter than the amalgamated Ca3a + La I, while the reverse takes place in the recent species.

Separated by a short notch follows a lamellar, strongly curved, prosocline tooth, having a deep socket on both ventral and dorsal side; this tooth is divided by a shallow furrow and represents Ca3p and Ca5p; its only difference from the similar tooth of the recent species consists of its being shorter and stronger curved. Then follows the ligament and behind it the long lamellar posterior lateral Lp I separated by a narrow socket from the much weaker Lp III; in the recent species the features are exactly alike.

b. *Left valve.*

There is a similar trifid anterior tooth close to the anterior margin, but in harmony with the right valve; the posterior branch representing Ca2a is rather small, while La II and La IV are much stronger than in the living species. Ca2p is short, lamellar, prosocline and strongly curved, separated by a long narrow socket, on the dorsal side from Ca4p, which is equally strongly curved. Then follows the ligament, and behind it the long lamellar Lp II, having a long socket on its dorsal side.

The hinge formula is therefore as follows:—

Right valve	La.	(III)	:	I	Ca.	3a	:	1	:	3p	: 5p	*L*	Lp. III	: I
Left valve	La.	(IV)	:	II	Ca.	2a	:	2p	:	4p	:	*L*	Lp.	II

Remarks.—As already said there is hardly any difference to be recorded between the hinge of the miocene *Meiocardia protovulgaris* and the recent *Meiocardia vulgaris*, except that in the former the hinge is more curved.

2.—ON THE VARIABILITY OF THE SHELL PELECYPODA.

INTRODUCTION.

Nearly everyone who had to deal with the description of Pelecypoda will have sorely felt the insufficiency of the terms applied to convey an idea of the shape of the shell. Not only are the terms mostly exceedingly vague, as, for instance, "somewhat roundedly quadrangular" or "subcylindrical" "orbicularly lenticular," etc., etc., instances which every one can easily discover for himself by going over the description in the majority of memoirs dealing with Pelecypoda, but in addition to those vague terms the personal equation comes in prominently. If terms as the above are used, it will be admitted that there are numerous instances by which different authors have described the shape of one and the same species in different terms, meaning however the same. It is quite obvious that the finer shades of the outline of a fossil, which of course has not an outspoken shape as, for instance, the genus *Solen*, must appear differently to the eye of different observers, and what one might describe as "transversely elongate," the other might call "oval," and the third "elliptical." Of course in a general sense these terms mean the same, and are not capable of being misunderstood, but supposing the term "transversely elongate" has been chosen, how are the varieties of shape to be described which are always to be observed whenever a large number of any species is examined? "Sub-transversely elongate," or "transversely sub-elongate," are delightful in their meaninglessness, but all the same they might be employed; but beyond this the language is too poor to express the finer shades in the variety of shape of a large number of individuals of one and the same species. We may at one extremity of the chain have individuals which are perfectly "orbicular," while at the other end are specimens which are "transversely elongate," both being connected by an uninterrupted chain of links which pass imperceptibly into each other. In such an instance the terminal links may be styled *var. orbicularis* and *var. elongata*, but no terms can be applied to the intermediate links, although the latter are of great value in judging the range of variation a single species may exhibit.

If it were possible to express the shape of a pelecypod shell by an easy mathematical formula, based on a system of rectilinear co-ordinates, the shape of each species and its varieties could be unmistakeably expressed. To my knowledge nobody has ever made an attempt in this regard; in fact this system as applied to Cephalopods or Gastropods has rather fallen into discredit, because its practical value was very small. But if we were to determine the general outline of a pelecypod shell by four points, being the terminal points of two lines, *viz.*, a horizontal antero-posterior one, representing the greatest length, and another perpendicular to it passing through the umbo, the general outline of the shell would be invariably fixed

by the co-ordinates of these four points. I wish, however, at once to say that I do by no means state that the above system would be perfectly sufficient for the description of the shell, as any amount of different shapes may be drawn inside of four given points; I wish merely to point the direction which researches of this kind might take. This is in my opinion a vast field hitherto left entirely unsearched, which promises very good results if diligently worked. These notions came quite by themselves when I started the examination of the Tertiary fossils from Burma, and when among the large material at my disposal I found numbers of well preserved specimens of one and the same species which by their variety of shape, particularly in the instance of *Arca (Anomalocardia) burnesi*, d'Arch., suggested some means to determine these varieties and to fix the probable limit of variety, as it is quite obvious that a given species must have limits to its variability, as otherwise it would become a different species.

I resorted to the old means of expressing the shape of each specimen by the fraction L/H, L being the greatest length, H the greatest height; the index thus obtained is of course independent of the size of the shell, and specimens of largely different sizes may have the same index. This index is also a very reliable guide in the description of a shell, as a short reflection into the limits of L/H will prove.

It is obvious that if $L=H$, the index L/H will be equal to 1. Shells having an index 1 or any figure more or less closely to it may generally be orbicular in shape, though of course this is by no means the rule and exceptions are frequent.

Now let us examine the case of L being greater than H, in this case the index will be greater than 1, and if we imagine that L continually grows while let us for the moment assume H remains constant, the index will necessarily become larger and larger. But if the length of a shell greatly exceeds its height we have, quite independent of the absolute measurements, a shell greatly stretched in antero-posterior direction, as we may say in the direction of the abscysse, or in plain words an elongate shell. *A large index L/H indicates therefore always an elongate shell independent of species, genus or absolute measurements.* This holds good in either case—whether L remains constant and H decreases, or H remains constant and L increases.

The limit is of course ∞, a case which however can never happen, as in this case the shell would have the shape of a line without any height stretched in the direction of the abscysse. The value must therefore be and it may safely be said very limited. In *Solen*, for instance, which most probably has the largest index, it is generally between 5·5 and 5·7, and hardly exceeds 6·0. We may, therefore, safely say that in all Pelecypods having an index above 1 it oscillates between 1 and 6.

In the second case L being smaller than H, the index must be smaller than 1, and if we again imagine that H grows continually, the index L/H will continue to become smaller and smaller. But if the length of a shell is much smaller than its height, we have, independently of absolute measurements, a shell greatly stretched in ventro-dorsal direction, or as we may say, in the direction of the ordinate, in plain words a high shell. *A small index L/H indicates therefore always a high shell, independent of species, genus or absolute measurements.*

The limit is in this case of course O, a case which also can never happen,

because the shell would have the shape of a line, but this time stretched in the direction of the ordinate. The value of L/H must therefore be always above O, but unfortunately I have at present no data available which is likely to be the lowest limit; however, this does not much matter, because it is a question of inferior importance.

The result of the above argumentation is that we are to a certain extent able to express the shape of a shell in figures, bearing in mind that a large index always represents elongate, a small index high shells, while those in the proximity of 1 are more or less orbicular. The two first rules are without any exception; if we found a *Trigonia* having an index of 5, this species would have a very elongated shell no matter how it looked otherwise, and if we found another *Trigonia* with an index 0·1 it would be a very highly stretched shell. Shells, however, which have the index 1 may be triangular, quadrangular or orbicular, and for this reason the index L/H alone is not quite sufficient to express the idea of the shape of the shell. As, however, the shape of all the species belonging to one and the same genus is one characteristic for this genus, the uncertainty is less than it would appear at the first moment. A *Trigonia* having an index 1 would certainly not be orbicular, while a *Pectunculus* of the same index would certainly not be triangular in shape.

Although the index L/H cannot be considered to solve the problem of describing the shell of a Pelecypod on a mathematical basis, it certainly affords a valuable assistance. If we were to know the range of indices of all the species belonging to a certain genus, a most valuable morphological character would be obtained. At present it is of no use trying to determine the index of a species from the figures given in memoirs, where it has been described, as it is impossible to judge as to the variation of the index of a certain species from an isolated specimen or figure only; but in any case where there is plenty of material of a species this feature should not be overlooked.

Whatever the value of the index L/H may be in generic regard, it is certainly highly valuable for examination of the specific variations and their value; in fact in this regard its value can hardly be under-estimated, particularly when the graphic method, which will be presently described, is applied.

II.—DESCRIPTIVE PART.

The instances serving to illustrate this method are fortunately such that they include an elongate shell exhibiting a large number of varieties, another one similar to the first, but a little less elongate, the index being nearer towards 1, while the third one exhibits a small number of varieties, and has an index hardly exceeding 1, and in addition an inequivalve species. All the specimens come from the miocene from Burma, *viz.*:—

1. *Arca* (*Anomalocardia*) *burnesi*, d'Archiac, from the *Parallelepipedum subrugosum* bed in the Lower Miocene.
2. *Arca* (*Anomalocardia theobaldi*), Noetling, from the *Arca* (*Anomalocardia*) *theobaldi* bed in the Lower Miocene.

3. *Cyrena* (*Batissa*) *crawfurdi*, Noetling, from the *Batissa* bed in the Upper Miocene.
4. *Cytherea erycina*, Linné, from the *Cytherea erycina* bed near Prome (probably Lower Miocene).
5. *Corbula subcrassa*, Noetling, from the *Arca* (*Anomalocardia*) *theobaldi* bed in the Lower Miocene.

1. ARCA (ANOMALOCARDIA) BURNESI, D'ARCHIAC AND HAIME.

MEASUREMENTS.*

	Length.	Height.	L/H.
a. Specimens having both valves.			
1.	24·4 mm.	16·5 mm.	1·57
2.	17·6 „	12·5 „	1·40
3.	14·1 „	10·1 „	1·40
4.	14·2 „	10·0 „	1·42
b. Right valve.			
5.	27·0 mm.	18·2 „	1·36
6.	26·5 „	16·5 „	1·60
7.	26·0 „	19·1 „	1·36
8.	25·5 „	14·5 „	1·62
9.	25·0 „	15·4 „	1·62
10.	24·8 „	15·2 „	1·63
11.	24·6 „	15·7 „	1·56
12.	24·4 „	15·4 „	1·58
13.	14·4 „	15·1 „	1·61
14.	24·4 „	16·0 „	1·52
15.	24·2 „	17·0 „	1·42
16.	23·6 „	15·3 „	1·54
17.	23·5 „	14·6 „	1·54
18.	23·2 „	15·9 „	1·52
19.	23·1 „	15·0 „	1·54
20.	22·5 „	14·7 „	1·54
21.	22·5 „	14·0 „	1·60
22.	22·4 „	15·7 „	1·42
23.	22·4 „	14·1 „	1·58
24.	22·4 „	13·5 „	1·65
25.	22·0 „	14·0 „	1·57
26.	21·9 „	14·9 „	1·46
27.	21·7 „	14·0 „	1·55
28.	21·6 „	14·4 „	1·50
29.	21·2 „	14·9 „	1·42
30.	21·0 „	14·8 „	1·41
31.	20·7 „	14·1 „	[illegible]
32.	22·0 „	13·7 „	1·60
33.	20·0 „	15·2 „	1·32
34.	20·3 „	15·0 „	1·35
35.	19·8 „	12·0 „	1·65
36.	18·7 „	12·8 „	1·39
37.	17·6 „	14·1 „	1·55
Right valve—*continued*.			
38.	13·6 mm.	9·4 mm.	1·44
39.	12·6 „	9·6 „	1·41
40.	12·8 „	9·9 „	1·30
41.	11·9 „	8·8 „	1·35
42.	11·0 „	7·8 „	1·42
43.	11·0 „	8·6 „	1·28
44.	10·9 „	7·3 „	1·49
45.	10·8 „	7·1 „	1·52
46.	10·5 „	7·5 „	1·40
47.	10·5 „	7·4 „	1·42
48.	10·5 „	6·7 „	1·56
c. Left valve.			
49.	27·5 mm.	18·2 „	1·51
50.	27·8 „	18·4 „	1·42
51.	26·7 „	16·8 „	1·58
52.	26·5 „	16·8 „	1·57
53.	26·2 „	17·1 „	1·54
54.	25·5 „	18·9 „	1·34
55.	25·2 „	17·4 „	1·44
56.	25·0 „	16·8 „	1·48
57.	24·6 „	18·6 „	1·32
58.	24·4 „	17·3 „	1·41
59.	24·3 „	16·5 „	1·47
60.	24·2 „	16·0 „	1·51
61.	24·1 „	17·1 „	1·40
62.	23·8 „	14·1 „	1·68
63.	23·6 „	17·1 „	1·38
64.	23·6 „	15·3 „	1·54
65.	23·6 „	15·4 „	1·53
66.	23·0 „	15·1 „	1·52
67.	23·0 „	16·5 „	1·40
68.	22·6 „	14·3 „	1·57
69.	22·6 „	15·2 „	1·48
70.	22·5 „	15·6 „	1·44
71.	22·5 „	16·4 „	1·37
72.	22·5 „	14·8 „	1·51
73.	22·4 „	15·3 „	1·46
74.	22·4 „	14·4 „	1·55

* The measurements were made with a calliper rule having a micrometer screw and a nonius, thus tenths of a millimeter could be read with greatest accuracy. Only fully preserved specimens were measured.

Left valve—continued. Length.	Height.	L/H.	*Left valve—concluded.* Length.	Height.	L/H.
75. 22·0 mm.	16·0 mm.	1·37	90. 16·0 mm.	11·0 mm.	1·45
76. 21·8 „	14·7 „	1·48	91. 15·3 „	10·8 „	1·41
77. 21·7 „	15·3 „	1·41	92. 14·8 „	11·1 „	1·33
78. 21·0 „	15·5 „	1·35	93. 14·2 „	10·0 „	1·42
79. 21·6 „	14·7 „	1·47	94. 13·5 „	9·6 „	1·40
80. 21·1 „	15·0 „	1·40	95. 12·9 „	9·2 „	1·40
81. 20·8 „	15·2 „	1·36	96. 12·3 „	9·0 „	1·36
82. 20·0 „	12·8 „	1·56	97. 10·7 „	8·3 „	1·29
83. 19·6 „	12·7 „	1·55	98. 10·2 „	6·8 „	1·50
84. 19·5 „	11·8 „	1·65	99. 10·2 „	7·8 „	1·29
85. 19·2 „	14·7 „	[illegible]	100. 9·3 „	6·8 „	1·36
86. 18·3 „	13·1 „	1·40	101. 8·0 „	6·3 „	1·27
87. 17·1 „	11·8 „	1·44	102. 7·6 „	5·3 „	1·43
88. 17·1 „	13·3 „	1·28	103. 4·9 „	4·2 „	1·17
89. 17·0 „	11·5 „	1·48			

In the above table the specimens have been arranged according to size in descending order, and in going through the figures it will be seen at once that absolute size and index L/H are in no relation whatsoever; the large specimen No. 5 has an index of 1·36, while specimen No. 49, which is of nearly the same size, has an index of 1·51; the first is, therefore, comparatively short, while the second is elongate; it will be further seen that comparatively young specimens may have a very high index, while others have a small one only; for instance, No. 48 has an index of 1·56, while No. 97, which is only 0·2 mm. smaller, has an index of 1·29. So far these figures tend to prove that there is no general rule with regard to the shape during the time of growth as might perhaps be supposed, young ones being more orbicular than full grown specimens. The figures seem rather to prove that the tendency to form the shape of the shell is developed at an early stage already, and is retained during the time of growth.

Another feature is however proved by these figures, and this is a great tendency towards variation, which ranges from 1·17 to 1·68. We have, therefore, two extreme varieties, one of which has an almost orbicular shell, while the other has a transversely elongate shell; if both specimens were found isolated, without the connecting links, I have not the slightest doubt that many a palæontologist would consider them as different species, by putting too great a stress on the external feature, the shape of the circumference of the valves, and yet these two specimens are only the extreme ends of an almost uninterrupted chain.

If, regardless of size, the specimens are arranged according to their indices in ascending order, underneath of each index the number of specimens being written, we obtain the following table :—

Index	1·17	1·18	1·19	1·20	1·21	1·22	1·23	1·24	1·25	1·26
Number of specimens	1	...	...	...	...	...	...	...	...	...
Index	1·27	1·28	1·29	1·30	1·31	1·32	1·33	1·34	1·35	1·36
Number of specimens	...	2	2	3	...	2	1	1	3	4

Index	1·37	1·38	1·39	1·40	1·41	1·42	1·43	1·44	1·45	1·46
Number of specimens .	2	1	1	9	5	8	1	4	1	3
Index	1·47	1·48	1·49	1·50	1·51	1·52	1·53	1·54	1·55	1·56
Number of specimens .	2	5	1	[illegible]	2	6	1	5	3	3
Index	1·57	1·58	1·59	1·60	1·61	1·62	1·63	1·64	1·65	1·66
Number of specimens .	4	3	...	6	1	2	1	...	3	...
Index	1·67	1·68	...	...	...	...	...	...	...	...
Number of specimens .	...	1	...	...	...	...	—	...	...	...

The above chain is almost uninterrupted from 1·28 to 1·65, there being only one gap each at 1·31, 1·59 and 1·64. I consider these gaps, however, so unimportant that I think am fully justified in saying that *Arca* (*Anomalocardia*) *burnesi* has an uninterrupted range of variety from index 1·28 to 1·63; in fact if we disregard the large gap at the beginning and the smaller at the end, we may say the amplitude extends from 1·17 to 1·68. This gives us at once a convenient scale to express the relative size of the range of variation in figures, which are comparable, amongst each other.

In the above species the range of variety extends over a number of 52 indices; we may, therefore, express this by a single sign such as var. 52, which means that the range of variety extends over a number of 52 indices. It is quite obvious, as will also be proved presently, that any other species having for instance var. 26 only, extends over a smaller number of indices, its range of variety is therefore smaller; we may in fact directly compare the amplitude of variation in two absolutely different species by saying the tendency of variation of species (*a*) having var. 26 is only half of that of species (*b*) having var. 52. This is, however, of smaller importance; the chief fact is that *the above method gives a convenient means to express in a concise way the amplitude of variation in any species, without using such vague terms as, varies much, varies little; and to express any variety by an index which not only fixes the place of the variety unmovingly in the whole range, but at the same time conveys an idea as to the shape of the variety.*

To return to the above instance, the whole feature could be expressed in the following short way :—

$$\text{Var. 52}\ \begin{matrix}1{\cdot}68\\ |\\ 1{\cdot}17\end{matrix}\quad \text{Average .}\begin{cases}1{\cdot}425\ \text{math.}\\ 1{\cdot}444\ \text{calc.}\end{cases}$$

which means that the range of variation extends over 52 indices, the smaller of which is 1·17; in other words contains comparatively orbicular shells, while the largest is 1·68, including the more elongate varieties. To the right of this might be written the actually computed average index, which is always different from the mathematical average index. The importance of the average index will be explained further on.

The above table contains some other remarkable features, which, in order to avoid repetition, will be explained later.

2. ARCA (ANOMALOCARDIA) THEOBALDI, Noetling.

Measurements.

a. Specimens having both valves.				Left valve—*continued*.			
	Length.	Height.	L/H.		Length.	Height.	L/H.
1.	14·7 mm.	10·8 mm.	1·36	23.	24·7 mm.	17·3 mm.	1·43
b. Right valve.				24.	19·6 „	15·1 „	1·30
2.	23·1 mm.	14·7 „	1·57	25.	19·2 „	14·0 „	1·37
3.	19·4 „	14·0 „	1·38	26.	17·8 „	13·7 „	1·30
4.	16·2 „	11·4 „	1·42	27.	17·7 „	13·2 „	1·34
5.	14·6 „	10·6 „	1·37	28.	17·0 „	12·8 „	[illegible]
6.	14·3 „	11·7 „	1·22	29.	16·3 „	12·8 „	1·27
7.	14·0 „	10·7 „	1·30	[illegible]	15·5 „	11·1 „	1·36
8.	14·0 „	10·5 „	1·34	31.	15·0 „	11·1 „	1·35
9.	12·4 „	8·8 „	1·40	32.	14·8 „	11·6 „	1·27
10.	12·1 „	9·0 „	1·34	33.	14·2 „	11·4 „	1·24
11.	11·9 „	9·2 „	1·29	34.	13·2 „	10·2 „	1·29
12.	11·4 „	8·2 „	1·39	35.	13·0 „	10·3 „	1·26
13.	9·7 „	7·5 „	1·30	36.	12·9 „	9·9 „	1·30
14.	9·3 „	6·9 „	1·34	37.	12·1 „	10·1 „	1·20
15.	8·2 „	6·4 „	1·28	38.	12·0 „	9·0 „	1·33
16.	7·3 „	5·7 „	1·28	39.	11·8 „	9·3 „	1·26
17.	7·2 „	5·7 „	1·26	40.	11·3 „	9·4 „	1·20
18.	6·7 „	5·2 „	1·28	41.	11·3 „	8·8 „	1·28
19.	6·6 „	4·9 „	1·34	42.	11·3 „	9·0 „	1·25
20.	6·0 „	4·3 „	1·39	43.	10·7 „	8·4 „	1·27
21.	6·0 „	4·5 „	1·33	44.	8·5 „	6·7 „	1·27
c. Left valve.				45.	7·7 „	6·5 „	1·18
22.	24·8 mm.	17·9 „	13·8				

The specimens have again been arranged according to size; and in going through these figures we notice the same feature, that the size of the index is independent of the absolute size of the shell. There is, however, another feature noticed, though not with great distinctness; it seems as if the younger specimens possessed a smaller index than the older ones, in other words that during the nealogic stage the shell had a more orbicular shape than in later stages. This feature would be of some significance, as it would prove that this species has been derived from a more orbicular species, and as it is highly probable that it is the descendant of *Arca* (*Anomalocardia*) *burnesi*, the more orbicular varieties of that species developed into this one.

If the indices are arranged in the same way as before, the following table results:—

Index . . .	1·18	1·19	1·20	1·21	1·22	[illegible]	1·24	1·25	1·26	1·27	1·28
Number of specimens	1	...	3	...	1	...	1	1	3	4	4
Index . . .	1·29	1·30	1·31	[illegible]	1·33	1·34	1·35	1·36	1·37	1·38	1·39
Number of specimens	3	5	...	1	2	5	1	2	2	2	2
Index . . .	1·40	1·41	1·42	1·43	1·44	1·45	1·46	1·47	1·48	1·49	1·50
Number of specimens	1	...	2	...	...	...	...	...	...	...	...
Index . . .	1·51	1·52	1·53	1·54	1·55	1·56	1·57				
Number of specimens	...	...	...	...	...	...	1				

The chain is almost uninterrupted from 1·24 to 1·42; there being only two gaps; taken as a whole the amplitude would range from 1·18 to 1·57, there being a large gap after 1·42. Variety 1·57 stands therefore quite by itself separated by a wide gap from the remainder, which range from 1·18 to 1·42. I have carefully examined var. 1·57, it is perfectly preserved and not squashed in any way, which might perhaps account for its elongate shape. As it is, it forms a solitary instance, while the majority of the shells prove that the tendency of the animal was rather to form orbicular than elongate shells. If var. 1·57 did not exist the variability of this species would be a comparatively small one, as it would only be var. 25. Under the above circumstances it is, however, greater, and the formula must be written—

$$\text{Var. 40} \; \begin{matrix} 1{\cdot}57 \\ | \\ 1{\cdot}18 \end{matrix} \; \text{Average} \;.\; \begin{cases} 1{\cdot}375 \text{ math.} \\ 1{\cdot}324 \text{ calc.} \end{cases}$$

The comparison of the two formulas of variety of two species so closely related as *Arca* (*Anomalocardia*) *burnesi* and *theobaldi*, the latter of which is most probably the descendant of the former, is of great interest.

In the first instance we see that the tendency of variation is much smaller in *Arca* (*Anomalocardia*) *theobaldi* than in *Arca* (*Anomalocardia*) *burnesi*, the respective figures being var. 40 and var. 52; in fact if it would not be for the isolated var. 1·57 of *Arca* (*Anomalocardia*) *theobaldi* the difference would be greater still, inasmuch as the figures were var. 25 and var. 52, in other words the tendency of variation in the first species would be half of that of the second.

We further see that both species occupy different positions in the line of indices, a feature which will, however, better be explained further on.

3. Cyrena (Batissa) crawfurdi, Noetling.

*Measurements.**

	Length.	Height.	L/H.		Length.	Height.	L/H.
1.	42·2 mm.	40·7 mm.	1·13	22.	32·0 mm.	27·0 mm.	1·14
2.	41·0 „	37·6 „	1·09	23.	31·4 „	27·4 „	1·14
3.	40·7 „	38·5 „	1·05	24.	31·0 „	27·0 „	1·13
4.	39·1 „	37·8 „	1·03	25.	29·4 „	26·4 „	1·11
5.	[illegible] „	34·6 „	1·12	26.	29·1 „	25·3 „	1·15
6.	38·6 „	35·6 „	1·06	27.	28·9 „	23·6 „	1·22
7.	37·0 „	33·6 „	1·13	28.	28·2 „	24·3 „	1·16
8.	[illegible] „	32·3 „	1·14	29.	25·6 „	23·8 „	1·07
9.	36·2 „	33·0 „	1·09	30.	27·0 „	23·0 „	1·17
10.	36·2 „	32·5 „	1·11	31.	26·9 „	22·5 „	1·19
11.	35·7 „	32·0 „	1·11	32.	25·6 „	22·3 „	1·14
12.	35·6 „	32·0 „	1·11	33.	24·8 „	21·4 „	1·15
13.	34·5 „	31·7 „	1·08	34.	23·9 „	21·6 „	1·10
14.	34·4 „	31·5 „	1·09	35.	23·8 „	21·4 „	1·11
15.	34·3 „	31·2 „	1·09	36.	22·0 „	20·3 „	1·08
16.	34·2 „	31·5 „	1·08	37.	21·2 „	18·8 „	1·12
17.	34·2 „	30·0 „	1·14	38.	21·0 „	19·4 „	1·08
18.	34·0 „	32·0 „	1·06	39.	19·2 „	17·5 „	1·09
19.	33·7 „	33·1 „	1·00	40.	15·7 „	13·7 „	1·14
20.	33·3 „	29·1 „	1·12	41.	14·0 „	12·5 „	1·12
21.	32·2 „	30·0 „	1·10	42.	13·3 „	12·0 „	1·10

* All specimens have both valves united.

As before, the specimens have been arranged according to size, and if ever it is evident that the index L/H is independent of absolute size, it is in this instance, the largest specimen having an index of 1·13, while the two smallest have 1·12 and 1·10, respectively.

For further discussion it will be well to arrange the specimens as before, according to size of index; this gives the following table:—

Index . . .	1·00	1·01	1·02	1·03	1·04	1·05	1·06	1·07	1·08	1·09
Number of specimens	1	...	...	1	...	1	1	1	3	5
Index . . .	1·10	1·11	1·12	1·13	1·14	1·15	1·16	1·17	1·18	1·19
Number of specimens	3	5	4	3	5	2	1	1	1	1
Index . . .	1·20	1·21	1·22	...	...	...	...	...	...	...
Number of specimens	...	...	1	...	...	...	...	...	...	...

We see, therefore, that the chain is uninterrupted from 1·05 to 1·19, but if we disregard the small gaps we have a range from 1·00 to 1·22. The formula of variety of this species would therefore be:—

$$\text{Var. } 23 \begin{array}{c} 1{\cdot}22 \\ | \\ 1{\cdot}00 \end{array} \text{ Average } . \left\{ \begin{array}{l} 1{\cdot}105 \text{ math.} \\ 1{\cdot}110 \text{ calc.} \end{array} \right.$$

If compared with the two preceding species it will be seen that *Cyrena (Batissa) crawfurdi* possesses a much smaller range of variety, and that it occupies quite a different position in the line of indices.

4. Cytherea erycina, Linné.

Measurements.

a. Right valve.	Length.	Height.	L/H.	*b. Left valve.*	Length.	Height.	L/H.
1.	57·8 mm.	47·2 mm.	1·22	19.	56·7 mm.	42·4 mm.	1·33
2.	56·5 „	46·0 „	1·23	20.	56·7 „	41·6 „	1·36
3.	55·0 „	40·8 „	1·34	21.	55·6 „	41·5 „	1·33
4.	50·2 „	37·8 „	1·33	22.	55·0 „	41·0 „	1·34
5.	50·0 „	39·0 „	1·28	23.	55·0 „	40·0 „	1·37
6.	49·6 „	39·2 „	1·26	24.	53·5 „	40·0 „	1·31
7.	48·4 „	36·8 „	1·31	25.	50·5 „	38·2 „	1·32
8.	47·0 „	36·7 „	1·28	26.	49·3 „	37·6 „	1·31
9.	46·7 „	35·4 „	1·31	27.	49·3 „	37·7 „	1·30
10.	46·6 „	35·6 „	1·31	28.	47·7 „	36·2 „	1·31
11.	46·0 „	34·7 „	1·32	29.	[illegible] „	33·0 „	1·35
12.	45·0 „	36·8 „	1·23	30.	39·6 „	30·5 „	1·29
13.	45·0 „	34·0 „	1·32	31.	37·3 „	26·4 „	1·41
14.	45·0 „	33·0 „	1·36	32.	37·1 „	29·7 „	1·25
15.	44·1 „	37·5 „	1·17	33.	36·4 „	27·7 „	1·31
16.	42·4 „	32·5 „	1·30	34.	36·3 „	28·1 „	1·29
17.	29·7 „	22·5 „	1·32	35.	34·0 „	25·3 „	1·34
18.	27·3 „	20·0 „	1·36	36.	30·2 „	23·5 „	1·28

If the above measured specimens are arranged according to the size of the index, the following table will be obtained :—

Index . . .	1·17	1·18	1·19	1·20	1·21	1·22	1·23	1·24	1·25	1·26	1·27	1·28	1·29	1·30	1·31
Number of specimens .	1	...	...	...	...	3	...	...	1	1	...	3	2	2	7
Index . . .	1·32	1·33	1·34	1·35	1·36	1·37	1·38	1·39	1·40	1·41					
Number of specimens .	5	2	3	1	3	1	...	...	...	1					

The index L/H does not show a great amplitude, as it varies from 1·17 to 1·41 only; the mathematical average would, therefore, be 1·29, but the calculated average is 1·319.

It will be seen that the chain is nearly uninterrupted between 1·25 and 1·37, and we may take it that the largest number of specimens will have an index within these limits; those having a smaller and higher index are so few, that we may consider them as rare exceptions. It will be seen that far the greatest number of specimens, *viz.*, 15 or 41·6°/$_o$ of the total are grouped between the indices 1·30 and 1·33, that is to say, around the calculated average index, a fact which is quite in harmony with the result obtained from the study of the varieties of other species. The above figures seem, however, to indicate that the tendency of variation is more towards the development of more orbicular than of elongate specimens.

The formula of variation should, therefore, be written as follows :—

$$\text{Var. } 25 \begin{array}{c} 1{\cdot}41 \\ | \\ 1{\cdot}17 \end{array} \text{ Average . } \left\{ \begin{array}{l} 1{\cdot}290 \text{ math.} \\ 1{\cdot}319 \text{ calc.} \end{array} \right.$$

5. Corbula socialis, Martin.

Measurements.

a. Right valve.

	Length.	Height.	L/H.
1.	17·5 mm.	11·5 mm.	1·52
2.	17·0 ,,	11·2 ,,	1·51
3.	14·8 ,,	9·2 ,,	1·60
4.	14·0 ,,	9·3 ,,	1·50
5.	13·4 ,,	9·0 ,,	1·49
6.	13·2 ,,	9·3 ,,	1·41
7.	13·0 ,,	8·9 ,,	1·34
8.	12·7 ,,	9·0 ,,	1·41
9.	12·4 ,,	8·8 ,,	1·40
10.	12·2 ,,	8·5 ,,	1·41
11.	12·1 ,,	8·9 ,,	[illegible]
12.	12·0 ,,	7·7 ,,	1·55
13.	11·9 ,,	8·5 ,,	1·40
14.	11·6 ,,	8·7 ,,	1·33
15.	11·5 ,,	8·0 ,,	1·43
16.	11·1 ,,	7·6 ,,	1·46
17.	10·8 ,,	8·6 ,,	1·25
18.	10·8 ,,	7·7 ,,	1·40
19.	10·8 ,,	7·5 ,,	1·44
20.	10·7 ,,	7·5 ,,	1·42
21.	10·1 ,,	6·4 ,,	1·57
22.	9·2 ,,	6·9 ,,	1·33
23.	6·9 ,,	4·1 ,,	1·68

b. Left valve.

	Length.	Height.	L/H.
1.	17·2 mm.	9·5 mm.	1·81
2.	14·9 ,,	9·0 ,,	1·65
3.	14·4 ,,	8·2 ,,	1·75
4.	13·7 ,,	8·8 ,,	1·55
5.	12·8 ,,	7·8 ,,	1·6
6.	12·4 ,,	7·7 ,,	1·61
7.	12·3 ,,	7·2 ,,	1·70
8.	12·0 ,,	8 0 ,,	1·50
9.	12·0 ,,	7·1 ,,	1·56
10.	11·9 ,,	7·8 ,,	1·53
11.	11·5 ,,	7·0 ,,	1·64
12.	11·4 ,,	7·4 ,,	1·54
13.	11·1 ,,	7·8 ,,	1·42
14.	9·6 ,,	6·7 ,,	1·43
15.	9·8 ,,	6·9 ,,	1·42
16.	9·2 ,,	5·9 ,,	1·56
17.	8·0 ,,	5·0 ,,	1·60

The study of the index of variation of this species seems to indicate that both valves of an inequivalve shell differ in their degree of variability, while no such feature is observed in equivalve shells; it will, therefore, be well to consider both valves separately.

(a) *Right valve.*—If arranged according to the size of the index the following table is obtained :—

Index . . .	1·25	1·26	1·27	1·28	1·29	1·30	1·31	1·32	1·33	1·34	1·35	1·36	1·37	1·38	1·39
Number of specimens .	1	...	...	...	...	...	...	...	2	1	1	...	...	...	...
Index . . .	1·40	...	1·41	1·42	1·43	1·44	1·45	1·46	1·47	1·48	1·49	1·50	1·51	[illegible]	1·53
Number of specimens .	3	3	...	1	1	1	...	1	...	...	1	1	1	1	...
Index . . .	1·54	1·55	1·56	1·57	1·58	1·59	1·60	1·61	1·62	1·63	1·64	1·65	1·66	1·67	1·68
Number of specimens .	...	1	...	1	...	...	1	...	...	...	..	...	...	...	1

It will be seen that the amplitude of the index L/H is rather a large one, extending from 1·25 to 1·68, but the chain exhibits frequent and sometimes large gaps; I am, however, convinced that they are chiefly due to the insufficient number of specimens I could examine; disregarding these gaps the average index would be 1·465 and the actual calculated average 1·443; there is, therefore, a considerable difference between the two; it is however noteworthy that, contrary to the observations made in other species, the majority of specimens does not group around or between these figures; the variation formula is therefore —

$$\text{Var. 44} \begin{matrix} 1{\cdot}68 \\ \vert \\ 1{\cdot}25 \end{matrix} \quad \text{Average} \;.\; \begin{cases} 1{\cdot}465 \text{ math.} \\ 1{\cdot}443 \text{ calc.} \end{cases}$$

(b) *Left valve.*—The above measurements give the following table for this valve :—

Index . . .	[illegible]	1·43	1·44	1·45	1·46	1·47	1·48	[illegible]	1·50	1·51	[illegible]	1·53	1·54	1·55	1·56
Number of specimens .	2	1	...	...	...	...	...	...	1	...	...	1	1	1	3
Index . . .	1·57	1·58	...	1·59	1·60	1·61	1·62	1·63	1·64	1·65	1·66	1·67	1·68	1·69	1·70
Number of specimens .	...	...	...	...	1	1	...	...	3	1	...	...	...	...	1
Index . . .	1·71	1·72	...	1·73	1·74	1·75	1·76	1·77	1·78	1·79	1·80	1·81	...	...	...
Number of specimens .	...	...	...	...	...	1	...	...	...	...	...	1	...	...	...

So far as can be judged from these figures, which owing to the large and frequent gaps might be considered as not sufficient to draw any conclusions from, the amplitude of the index L/H is a large one, ranging from 1·42 to 1·81; the mathematical average would, therefore, be 1·605 and the calculate done 1·582, the former being, as in the right valve, slightly larger. The formula of variation should, therefore, be written—

$$\text{Var. 40} \begin{matrix} 1{\cdot}81 \\ \vert \\ 1{\cdot}42 \end{matrix} \quad \text{Average} \;.\; \begin{cases} 1{\cdot}605 \text{ math.} \\ 1{\cdot}582 \text{ calc.} \end{cases}$$

Now if the formulæ of both valves are compared, some remarkable features are at once noticeable, which are probably not merely accidental. In the first

instance we see that the amplitude of variation is nearly the same in both valves, it being var. 44 and var. 40 respectively; but it is further unquestionable that the amplitude of the right valve includes smaller indices than that of the left valve, in other words the left valve of this species is generally more elongate than the right one; the average indices being—

	Right valve.		*Left valve.*
Math.	1·465.	... ...	1·605.
Calc.	1·443.	... ...	1·562.

The difference in the shape of the valves is exceedingly well illustrated by the above figures, and I question whether it would be possible to express this difference in a clearer and conciser way.

If on the basis of the above figures both valves are taken together as in equivalve shells, the formula of variation would be :—

$$\text{Var. 57}\ \begin{matrix} 1{\cdot}81 \\ | \\ 1{\cdot}25 \end{matrix}\ \text{Average}\ .\ \begin{cases} 1{\cdot}530\ \text{math.} \\ 1{\cdot}502\ \text{calc.} \end{cases}$$

It may, however, be questioned whether this way of describing the variability of an inequivalve shell is justifiable.

III.—CONCLUSIONS.

The above instances would be quite sufficient in support of my view, that the shape of a pelecypod shell and its delicate and minute variations can to some degree be expressed better by figures than by words. This figure, the index L/H, is perfectly sufficient to convey an idea as to the tendency of variation within the limits of one and the same species, and that it serves to determine in an unmistakable way a given variety, and that by means of it we are able to express the amplitude of variation in a short formula which admits of no mistake, and which at the same time admits the comparative study of the variation of two different species.

It will, however, be particularly illustrative if the graphic method is applied; a number of features, which are not so conspicuous when expressed by figures only, are at once noticed. For this purpose the indices were written on the abscisse, from left to right, beginning with 1·00.[1] The number of specimens having the same index were entered on the ordinate, and by this means a curve, which might be designated the "curve of variation," was obtained which allowed to see at a glance all the features of variation of a given species. A few theoretical considerations will, however, be useful before going into details. It is obvious that if all specimens of a certain species had the same index, that is to say, if they were all exactly alike and no variations existed, the curve of variation would be a straight line in the direction of the ordinate; while if all had a different index, that is to say, if they were all different in shape, the curve of variation would be a straight line in the direction of the abcisse. The flatter and longer therefore the curve of variations is the larger

[1] Of course all indices below 1·00 must be written in reversed order, that is to say, from right to left.

is the number of varieties; the higher and shorter, the smaller is the number of varieties.

Further, the position of the curve will at once show the general shape of the shell, whether an elongated or short orbicular shape is predominant, and in which direction the tendency of variation is larger.

After this remark we may go into special cases; and as the first instance *Arca* (*Anomalocardia*) *burnesi* may be taken. It must of course be understood that the curve as depicted is only approximately, and that certain features which may appear as details are only due to the insufficiency of material. I have, for instance, not the slightest doubt that the gaps at the beginning or, say, at 1·59 or 1·64 would be filled out if the material was only double the number. I have further no doubt that lacunæ at 1·45, 1·49, 1·53, etc., would be filled out if more material could be examined; as it is we must be satisfied with an approximate line only, which is, however, of sufficient interest.

The curve rises very slowly from 1·17 to 1·36, which indicates that varieties of the orbicular type are rather rare; from 1·36 to 1·39 there seems to be a drop, of which, however, I am not quite sure whether it really exists or is only due to insufficiency of material; if the bulging out of the curve at 1·36 really existed it would mark an interesting feature, as it would prove that certain varieties are very regularly and frequently developed; however that may be, it is quite certain that rather a sudden rise takes place from either 1·36 or 1·39 to 1·40, and that a large number of specimens, 22 or 21·3 per cent. of the total, group themselves around 1·40, 1·41, 1·42; from here the curve begins to drop; it is not quite certain whether, suddenly or not, but it is quite certain that it drops, and that it extends over a considerable length, and that, therefore, the drop is less sudden than the rise; the analysis of the curve therefore proves that the number of varieties below 1·40 is rather small, but that they are extended over a considerable length, that those above 1·42 are more numerous but also extended over a large space, and that those from 1·40 to 1·42 are massed together, nearly one-quarter (21·3 per cent.) of the total number falling under these indices. If we examine the average value of the index L/H we find that its mathemetical value is 1·425. Is it not a *remarkable feature that most of the specimens are grouped around the average index?* The curve shows futher by its unsymmetrical feature, it being longer towards the higher indices, that that tendency of *Arca* (*Anomalocardia*) *burnesi* is rather to develop elongate than orbicular.

In the next species *Arca* (*Anomalocardia*) *theobaldi*, we see rather a different curve; we notice at once that it has shifted further towards left, that is to say, that the tendency of variation rather inclines towards the development of orbicular than of elongate varieties. The curve rises slowly up to 1·30, and though there is lacuna at 1·31, 1·32 and 1·33, I have no doubt that they are only due to the insufficiency of the material; from 1·34 it begins to drop towards 1·42, and from there very slowly towards 1·58.

If the average value of the index is computed it will be seen that it amounts to 1·375, that is to say, at a place which is only occupied by a few specimens; if,

however, the average is computed after omission of var. 1·58, the number is 1·30 and indicates the place of highest bulging out of the curve, and which nearly coincides with the calculated average index 1·324; it is, therefore, again the same feature as we have observed in the former species, and var. 1·58 must be considered as an anomaly, perhaps an atavistic element.

It is certainly noticeable that ***Arca*** **(*Anomalocardia*)** ***theobaldi*** shows its chief development in that part of the index-line where ***Arca*** **(*Anomalocardia*)** ***burnesi*** shows its minimum, except for the remarkable bulging out at 1·36. It is, therefore, very probable that ***Arca*** **(*Anomalocardia*)** ***theobaldi*** has developed from the more orbicular varieties of ***Arca*** **(*Anomalocardia*)** ***burnesi*** considering how nearly related this species are. This view may be further strengthened by the fact that in the nealogic stage ***Arca*** **(*Anomalocardia*)** ***theobaldi*** is usually more orbicular than at later stages.

This observation seems to indicate another direction in which the study of the curve of variation may be of great value. Any curve which exhibits an irregular course, in which there is a strong and sudden bulging out at different places, indicates that there are certain varieties which are developed in preference to others. May not these varieties give birth to new species in later strata? It would be certainly well worth following up this line of research, although it is rather a difficult one and requires plenty of material for examination.

The curve of variation of *Cyrena* (*Batissa*) ***crawfurdi*** is a very simple one, in fact it seems that we have here a species which hardly develops any tendency towards variation; the curve remains very flat up to 1·07, then there is a certain rise, and between 1·08 and 1·14 there are 30 specimens or 71 per cent. of the total number massed together, from there it drops again, and varieties above 1·14 are as scarce as those below 1·08. The average index 1·11 falls right into the middle of the large mass 1·08 to 1·14; we would, therefore, have again the same feature as noticed below: the majority of specimens are grouped around the average index L/H.

It may be remarked that the curve of this species being still further to the left, indicates that we have a species the general outline of which is more or less orbicular.

The above remarks have certainly proved the value of the index L/H with regard to the study of the varieties of a certain species, and that very good and illustrative results may be obtained by the graphical method.

Calcutta, March 1898.

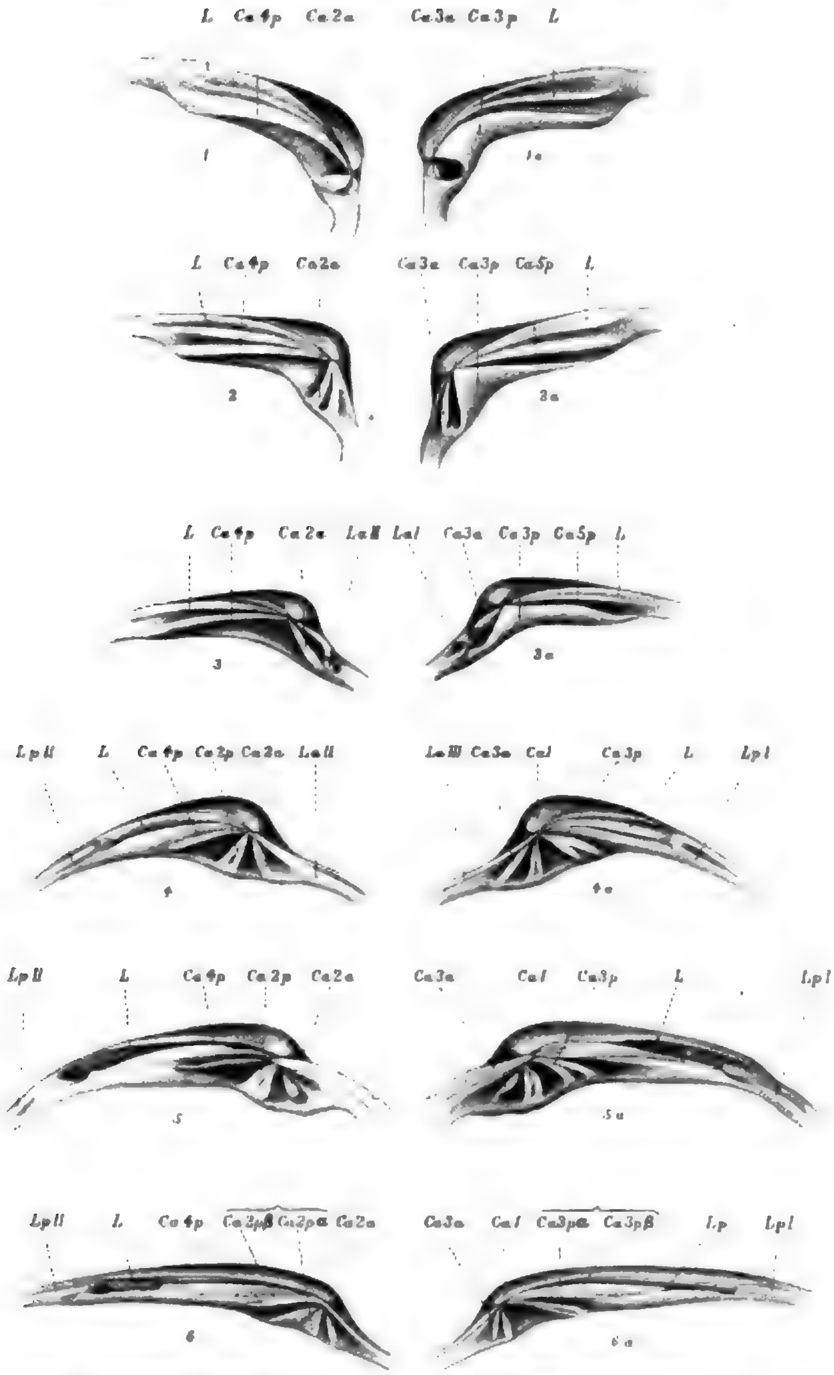


Fig 1, 1a Mytilicardia variegata Brug

Fig 2, 2a Mytilicardia subvariegata Noetl

Fig 3, 3a Venericardia viquesneli d'Arch & Haime

Fig 4, 4a Chamelea [illegible] Lin

Fig 5, 5a Venus puerpera Lin

Fig 6, 6a Tapes adspersa Lam

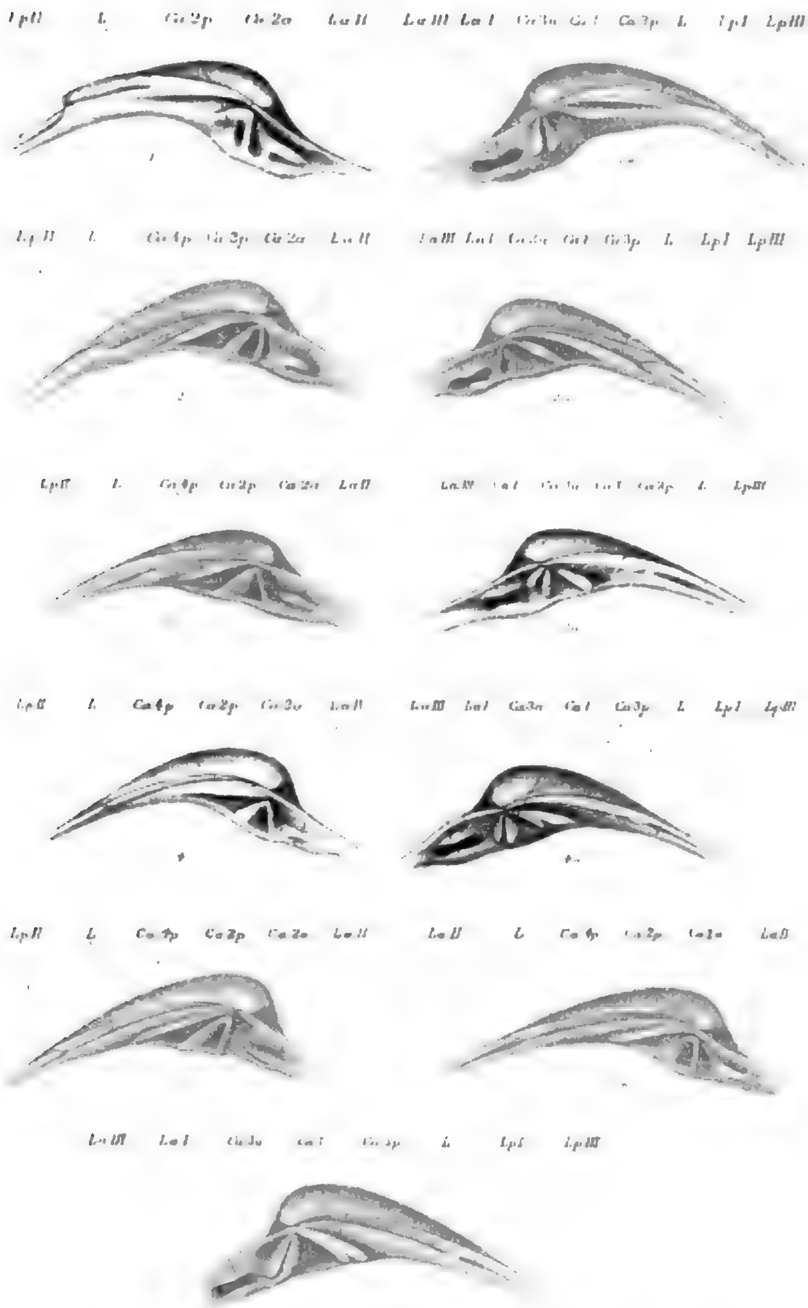


Fig 1. [illegible]

Fig 2. [illegible]

Fig 3. 3a. Dione [illegible]

Fig 4. 4a. Dione subphilippinarum Noetl

Fig 5. Dione arrakanensis Noetl

Fig 6. Dione [illegible] Noetl

Fig 7. Dosinia [illegible] Noetl

GEOLOGICAL SURVEY OF INDIA.

Dr Noetling

Palaeontologia Indica Vol.I Pl IV.

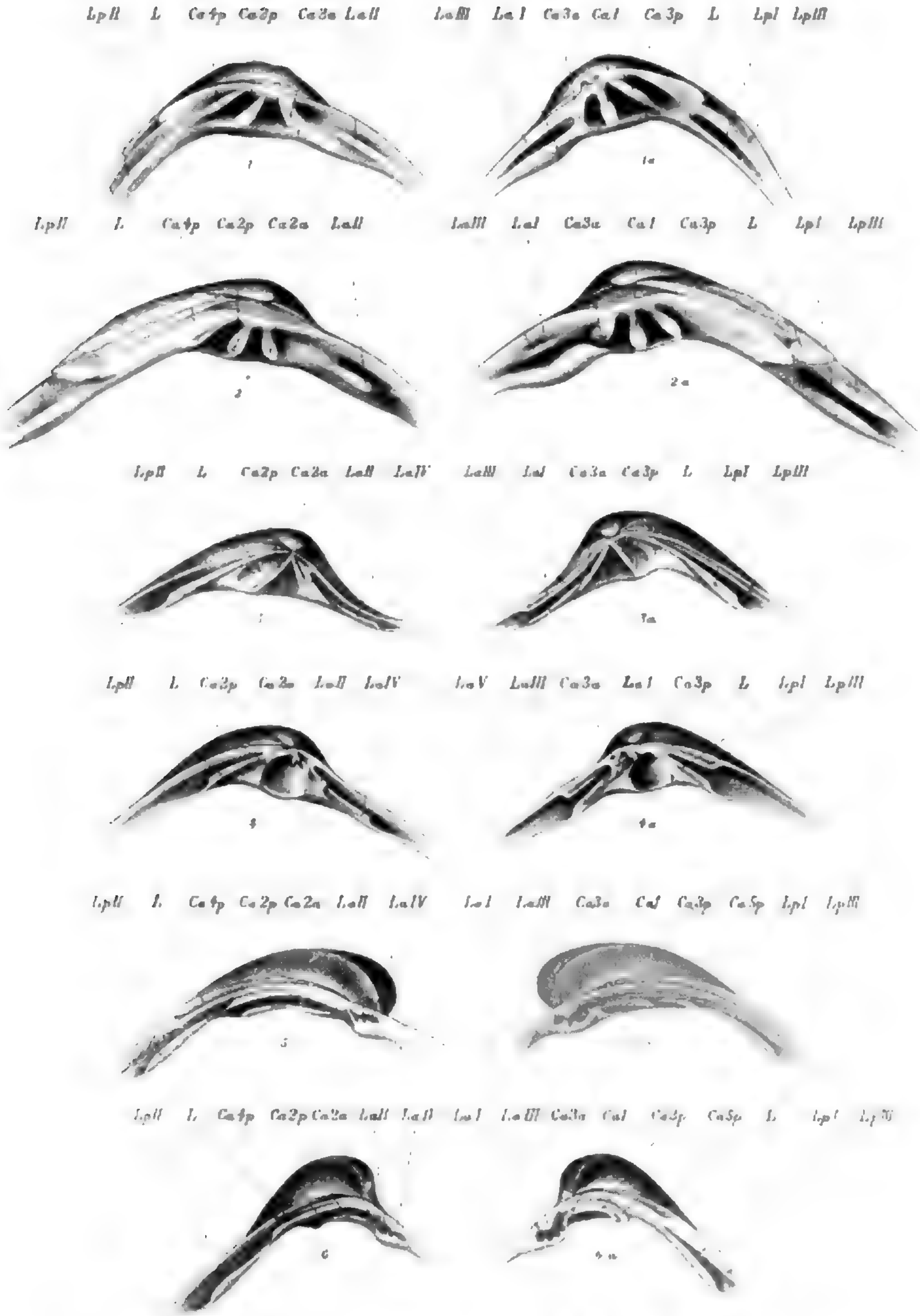


Fig 1, 1a Cyrena crawfurdi Noetl.

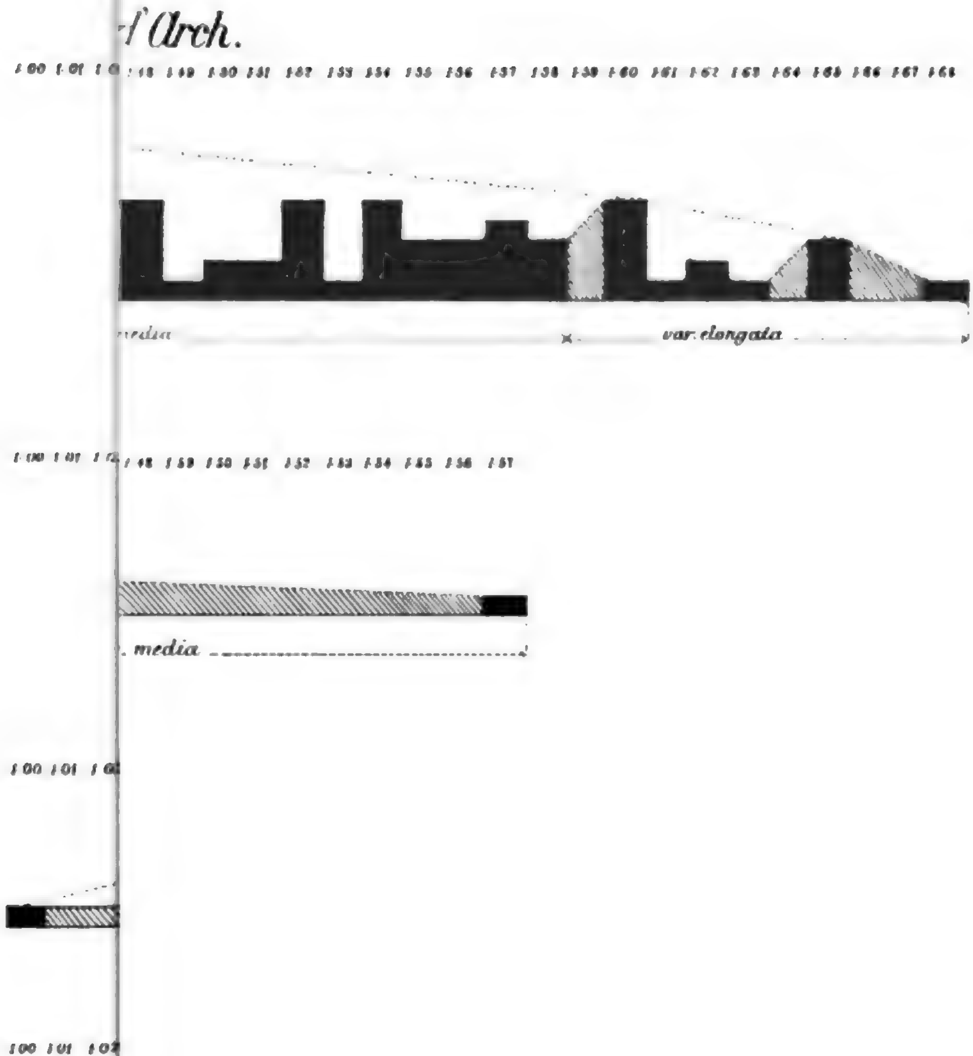
Fig 2, 2a Cyrena galateae Morch

Fig 3, 3a Mactra subreversa Noetl.

Fig 4, 4a Mactra laevis Lin.

Fig 5, 5a Meiocardia vulgaris Reeve

Fig 6, 6a Meiocardia protovulgaris Noetl.


Arch.
media
var. elongata
. media

MEMOIRS

OF

THE GEOLOGICAL SURVEY OF INDIA.

Palæontologia Indica,

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

New Series.

Vol. I.

3.—FAUNA OF THE MIOCENE BEDS OF BURMA.

PLATES I TO XXV.

By

FRITZ NOETLING, Ph.D., F.G.S.,

Palæontologist, Geological Survey of India.

CALCUTTA:

SOLD AT THE

GEOLOGICAL SURVEY OFFICE.

LONDON: KEGAN PAUL, TRENCH, TRÜBNER & CO.

MDCCCCI.

PRINTED BY THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA, 8, HASTINGS STREET, CALCUTTA.

MEMOIRS OF THE GEOLOGICAL SURVEY OF INDIA.

VOL. I. Royal 8vo, pp. 309, 1859 (*out of print*). Pt. 1, 1856 (*price* 1 Re.): Preliminary notice on the Coal and Iron of Talchir.—On the geological structure and relations of the Talchir Coal-field.—Gold-yielding deposits of Upper Assam.—On specimens of gold and gold dust from Shué-gween. Pt. 2, 1858 (*price* 2 Rs.): On the geological structure of a portion of the Khasi Hills.—On the geological structure of the Nilghiri Hills (Madras). Pt. 3, 1859 (*price* 2 Rs.): On the geological structure and physical features of the Districts of Bankura, Midnapore, and Orissa.—On the laterite of Orissa.—On some fossil fish-teeth of the genus Ceratodus, from Maledi, south of Nagpur.

VOL. II. Royal 8vo, pp. 341, 1859 (*out of print*). Pt. 1, 1860 (*price* 2 Rs.): On the Vindhyan Rocks, and their associates in Bundelkund. Pt. 2, 1860 (*price* 3 Rs.): On the geological structure of the central portion of the Nerbudda District.—On the tertiary and alluvial deposits of the central portion of the Nerbudda Valley.—On the geological relations and probable geological age of the several systems of rocks in Central India and Bengal.

VOL. III. Royal 8vo, pp. 438. Pt. 1, 1863 (*price* 3 Rs.): (*out of print*). On the geological structure and relations of the Raniganj Coal-field.—Additional Remarks on the geological relations and probable geological age of the several systems of rocks in Central India and Bengal.—Indian Mineral Statistics, I. Coal. Pt. 2, 1864 (*price* 2 Rs.): On the Sub-Himálayan Ranges between the Ganges and Ravi.

VOL. IV. Royal 8vo, pp. 450. Pt. 1, 1863 (*price* 2 Rs.): Report on the Cretaceous Rocks of Trichinopoly District, Madras. Pt. 2, 1864 (*price* 2 Rs.): (*out of print*). On the structure of the Districts of Trichinopoly, Salem, etc. Pt. 3, 1865 (*price* 1 Re.): On the Coal of Assam, etc.

VOL. V. Royal 8vo, pp. 354. Pt. 1, 1865 (*price* 3 Rs.): (*out of print*). Sections across N.-W. Himálaya, from Sutlej to Indus.—On the Gypsum of Spiti. Pt. 2, 1866 (*price* 1 Re.): On the Geology of Bombay. Pt. 3, 1866 (*price* 1 Re.): (*out of print*). On the Jherria Coal-field.—Geological Observations on Western Tibet.

VOL. VI. Royal 8vo, pp. 395. Pt. 1, 1867 (*price* 8 As.): On the Neighbourhood of Lynyan, etc., in Sind.—Geology of a Portion of Cutch. Pt. 2, 1867 (*price* 2 Rs.): (*out of print*): Bokáro Coal-field.—Rámgarh Coal-field.—Traps of Western and Central India. Pt. 3, 1869 (*price* 2 Rs. 8 As.). Tapti and Nerbudda Valleys.—Frog-beds in Bombay.—*Oxyglossus pusillus.*

VOL. VII. Royal 8vo, pp. 342. Pt. 1, 1869 (*price* 3 Rs.): Vindhyan Series.—Mineral Statistics.—Coal.—Shillong Plateau. Pt. 2, 1870 (*price* 1 Re.): Karharbári Coal-field.—Deoghar Coal-field. Pt. 3, 1871 (*price* 1 Re.): Aden Water-supply.—Káranpura Coal-fields.

VOL. VIII. Royal 8vo, pp. 353. Pt. 1, 1872 (*price* 4 Rs.): On the Kadapah and Karnul Formations in the Madras Presidency. Pt. 2, 1872 (*price* 1 Re.): Itkhuri Coal-field.—Daltonganj Coal-field.—Chope Coal-field.

VOL. IX. Royal 8vo, pp. iv, 358. Pt. 1, 1872 (*price* 4 Rs.): Geology of Cutch. Pt. 2, 1872 (*price* 1 Re.): Geology of Nagpúr.—Geology of Sirban Hill.—Carboniferous Ammonites, pp. 65.

VOL. X. Royal 8vo, pp. 359. Pt. 1 (*price* 3 Rs.): Geology of Madras.—Sátpura Coal-basin. Pt. 2, 1874 (*price* 2 Rs.): Geology of Pegu.

VOL. XI. Royal 8vo, pp. 338. Pt. 1, 1874 (*price* 2 Rs.): Geology of Dárjiling and Western Duars. Pt. 2, 1876 (*price* 3 Rs.): Salt-region of Kohát, Trans-Indus.

VOL. XII. Royal 8vo, pp. 363. Pt. 1, 1877 (*price* 3 Rs.): South Mahrátta Country. Pt. 2, 1876 (*price* 2 Rs.): Coal-fields of the Nága Hills.

VOL. XIII. Royal 8vo, pp. 248. Pt. 1, 1877 (*price* 2 Rs. 8 As.): Wardha Valley Coal-field. Pt. 2, 1877 (*price* 2 Rs. 8 As.): Geology of the Rájmahál Hills.

VOL. XIV. Royal 8vo, pp. 313, 1878. Geology of the Salt-range in the Punjab.

VOL. XV. Royal 8vo, pp. 192. Pt. 1, 1878 (*price* 2 Rs. 8 As.): Geology of the Aurunga and Hutár Coal-fields (Palamow). Pt. 2, 1880 (*price* 2 Rs. 8 As.): Ramkola and Tatapani Coal-fields (Sirguja).

VOL. XVI. Royal 8vo, pp. 264. Pt. 1, 1879 (*price* 1 Re. 8 As.): Geology of Eastern Coast from Lat. 15° to Masulipatam. Pt. 2, 1880 (*price* 1 Re. 8 As.): The Nellore Portion of the Carnatic. Pt. 3, 1880 (*price* 2 Rs.): Coastal region of the Godávari District.

VOL. XVII. Royal 8vo, pp. 305. Pt. 1, 1879 (*price* 3 Rs.): Geology of Western Sind. Pt. 2, 1880 (*price* 2 Rs.): Trans-Indus extension of the Punjab Salt-range.

VOL. XVIII. Royal 8vo, pp. 300. Pt. 1, 1881 (*price* 2 Rs.): Southern Afghanistan. Pt. 2, 1881 (*price* 1 Re. 8 As.) (*out of print*): Mánbhum and Singhbhum. Pt. 3, 1881 (*price* 2 Rs.): Pránhita-Godávari Valley.

VOL. XIX. Royal 8vo, pp. 242. Pt. 1, 1882 (*price* 2 Rs.): The Cachar Earthquake of 1869. Pt. 2, 1882 (*price* 1 Re.). Thermal springs of India. Pt. 3, 1883 (*price* 1 Re.): A catalogue of Indian Earthquakes. Pt. 4, 1883 (*price* 1 Re.): Geology of parts of Manipur and the Nága Hills.

VOL. XX. Royal 8vo, pp 240, Pt. 1, 1883 (*price* 2 Rs. 8 As.): Geology of Madura and Tinnevelly. Pt. 2, 1883 (*price* 2 Rs. 8 As.): Geological notes on the hills in the neighbourhood of the Sind and Punjab Frontier between Quetta and Dera Ghazi Khan.

VOL. XXI. Royal 8vo, pp. 286 (*out of print*). Pt. 1, 1884 (*price* 2 Rs.): Geology of the Lower Nerbudda Valley. Pt. 2, 1884 (*price* 1 Re.): Geology of Kathiawar. Pt. 3, 1885 (*price* 2 Rs.): Coal-field of South Rewah. Pt. 4, 1885 (*price* 1 Re.): Barren Island.

VOL. XXII. Royal 8vo, pp. 344, 1883. The Geology of Kashmir, Chamba, and Khagan.

VOL. XXIII. Royal 8vo, pp. 232, 1891. Geology of the Central Himálayas.

VOL. XXIV. Royal 8vo, Pt. 1, 1887 (*price* 1 Re. 8 As.): The Southern Coal-fields of the Sátpura Gondwána Basin. Pt. 2, 1890 (*price* 2 Rs. 4 As.): Physical Geology of the Sub-Himálaya of Garhwál and Kumaun. Pt. 3, 1890 (*price* 1 Re. 4 As.): Geology of South Malabar, between the Beypore and Ponnáni Rivers.

VOL. XXV. Royal 8vo, 1896. Geology of the Bellary District, Madras Presidency.

VOL. XXVI. Royal 8vo, 1896. Geology of Hazara.

VOL. XXVII. Royal 8vo Part 1, 1895 (*price* 1 Re.): Marine Fossils from the Miocene of Upper Burma. Pt. 2, 1897 (*price* 4 Rs.): Occurrence of Petroleum in Burma, and its technical exploitation.

VOL. XXVIII. Royal 8vo. Pt. 1, 1898 (*price* 2 Rs.): Notes on the Geological Structure of the Chitichun region. A note on the Allah-bund in the north-west of the Rann of Kuchh. Geology of parts of the Myingyan, Magwe and Pakokku Districts, Burma. The Geology of the Mikir Hills in Assam. On the Geology of Tirah and the Bazár Valley. Part 2, 1900 (*price* 3 Rs.): The Charnockite Series, a group of Archæan Hypersthenic Rocks in Peninsular India.

Vol. XXIX. Royal 8vo, 1900 (*price* 5 Rs.): Report on the Great Earthquake of 12th June 1897.

Vol. XXX. Royal 8vo, Part 1, 1900 (*price* 2 Rs.): Aftershocks of the Great Earthquake of 12th June 1897. Pt. 2, 1900 (*price* 1 Re.): Geology of the neighbourhood of Salem, Madras Presidency, with special reference to Leschenault de la Tour's observations.

Vol. XXXIII. Royal 8vo, Part 1, 1901 (*price* 8 Rs): The Kolar Gold-Field, being a description of Quartz-mining and Gold-recovery as practised in India.

The price fixed for these publications is 5 Rs. (10s.) each volume.

Palæontologia Indica.

NEW SERIES.

VOL. I.

3.—FAUNA OF THE MIOCENE BEDS OF BURMA.

3. THE FAUNA OF THE MIOCENE BEDS OF BURMA,

BY

FRITZ NOETLING, PH.D., F.G.S.,

PALÆONTOLOGIST, GEOLOGICAL SURVEY OF INDIA.

INTRODUCTION.

The following pages contain the result of my examination of the Tertiary system of Burma as far as I have been able to study it during my stay in Burma. The stratigraphical observations have been supported by a careful examination of the fossils collected by myself and others.

My collections came chiefly from the *Irrawaddi* series near Yenangyoung, the zones of *Cancellaria martiniana* of Minbu and *Paracyathus caeruleus* of Yenangyat. A short description of the fossils from the last named beds was published by me some years ago.[1] Subsequently I discovered the interesting fauna of the zone of *Meiocardia metavulgaris* near Singu, and the late Mr. Grimes collected some good specimens in the zone of *Mytilus nicobaricus* near the same locality. When I started to determine and describe these new collections, I found it advisable to include in these researches the collections made some 30 years ago by Messrs. Theobald and Fedden in Lower Burma. The work of sorting these specimens, which had remained unpacked since they were collected, was rather a difficult one; there was a good deal of inferior material, without any reference to stratigraphical position or locality, but after rejecting everything doubtful, there remained a fine collection which chiefly served for the description of the fossils.

When I commenced the determination and description I little guessed what a tremendous task it would prove to be, chiefly on account of the non-existence of any reliable literature. I soon discovered that the fine palæontological works on the Tertiary system of Europe were of no use whatsoever for the determination of the Miocene fossils from Burma, and as regards the memoirs dealing with the Tertiary fossils of India, they are almost *nil*.

There are of course the excellent monographs of Messrs. Duncan and Sladen on the Corals and Echinoidea of Western India, but they proved of little avail, because both classes were only represented by seven species in all, among my collections. Besides these memoirs, fully up to the modern standard, there were

[1] On some Marine fossils from the Miocene of Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, pt. 1.

only J. de Carl Sowerby's notes on some Tertiary fossils from Cutch, and Messrs. d'Archiac and Haime's *Description des Fossiles du groupe Nummulitique de l'Inde.*

As regards the first paper,[1] it is hardly of any use at all; the figures though perhaps up to the standard of 1840, are almost useless for determination, and the short explanatory notes are not sufficient to clear up doubtful points. It may perhaps be possible to recognize the species, once the fossils which have been collected at the same locality, as those figured by Sowerby, come to be described, but as means of determination, when Tertiary fossils from other parts of India are examined, they are almost of no value.

The second memoir, Messrs. d'Archiac and Haime's description of the fossils from the "Nummulitic" group of Sind[2] is almost worse than Sowerby's notes. Quite apart from that the authors have described fossils from different formations, Cretaceous, Eocene and Miocene, as coming from one and the same series, many of the species figured, particularly those of the Pelecypoda and Gastropoda, are in such a poor state of preservation, often only casts of the most indifferent type, that it is impossible to make use of this book at all. In fact Messrs. d'Archiac and Haime's "Description" is worse than useless, as anybody who had to consult this book has found out.[3]

I consider the "Description" as a serious impediment towards the advancement of our knowledge of the Tertiary system in India, and unless a revision of the work is undertaken, and the type specimens carefully compared with others, the exact horizon of which is known, it will remain so. As it is, every author dealing with the Tertiary system of India is obliged to consult the "Description" and as a result of his labours errors creep in, which can only be avoided if one chooses to disregard Messrs. d'Archiac and Haime's determinations altogether.

On the other hand, the different publications on the Tertiary fauna of Java, which by the undefatigable exertions of Professor Martin in Leiden have been brought up to such a perfection, as to remain standard works for all the time to come, were of the greatest assistance to me. It is partly due to these excellent palæontological memoirs that I have been able to arrive at some definite views with regard to the Miocene of Burma. Yet, excellent as these publications are, it will be understood that they could not be of the same value as papers dealing with the palæontology of the Indian Tertiaries.

Literary support thus almost failing, I was entirely left to my own resources to solve a problem which bristled with difficulties. Only thirty years ago, the matter would have been treated quite differently, the fossils would have been described, figured and new names given to all of them, but the remarkable features of the fauna would have been entirely overlooked.

Stoliczka[4] already recognized that if the fauna of the Tertiary system of Burma

[1] Transactions of the Geolog. Soc. of London, 2nd series, 1840, Vol. V. Strictly speaking, this is no paper at all; there are a few plates of fossils accompanying Captain Grant's paper on the Geology of Cutch, to which Sowerby furnished the explanations. Those explanations of plates, which are perhaps a little more extensive than such explanations usually are, represent the only description to go upon when Sowerby's fossils are referred to.

[2] D'Archiac and Haime, Description des Animaux fossiles du groupe Nummulitique de l'Inde. Paris, 1853.

[3] Martin, Tertiärschichten auf Java, General part. page 23.

[4] Theobald, The Geology of Pegu, Mem. Geolog. Survey of India, 1873, Vol. X, page 80.

were to be described, satisfactory results would only be arrived at, if at the same time it were compared with the fauna of the Indian Ocean, a view which I could soon confirm. The determinations of the fossils were therefore carried out by comparing them at the same time with recent species from the Indian Ocean.

Yet, easy as it may seem, this comparison was by no means an easy matter, and often was I put to the question, is a certain species identical with a recent one or not? It may seem absurd that any such doubts can arise as to identity or not, yet if a fauna like that of the Miocene of Burma comes to be described, numbers of species will come under examination, which, though not quite identical, do not exhibit features to justify a specific separation. In such cases the personal equation comes in, and it is quite probable that another author would take a different view from my own as to identity of species. I have, however, classified all those species of which I had any doubts separately, and their specific name has been formed by adding the prefix *proto* to the name of the recent species next related to the fossil one.

I am greatly indebted to Major Alcock, I.M.S., Superintendent of the Indian Museum, for permitting me to study the rich collection of recent species from the Indian Ocean in the Indian Museum. The satisfactory results which have been obtained are chiefly due to these comparative studies, and I particularly wish to tender my best thanks to Major Alcock.

It will be seen from the general part, that quite a new line of research has been opened out for the study of the Indian Tertiary system, which affords some most interesting views regarding not only the origin of the recent fauna of the Indian Ocean, but also to the relation the Miocene of India-Burma had with the older Tertiary system of Europe and the recent fauna of the Western Pacific. In fact, I think that one of the most important of my results is the proof of a migration of species from Europe in eastern direction, which commenced with the Eocene and probably lasted through the Miocene,—a migration which still continued in eastern direction during the Miocene period in India-Burma, though all direct communication between the Miocene Ocean of Europe and India was disconnected during the Miocene period.

I further trust that the description of fossils will serve as a sound basis on which future researches regarding the Tertiary of India can rely upon.

FRITZ NOETLING.

Calcutta, August 1899.

GENERAL PART.

I.—THE DEVELOPMENT AND SUB-DIVISION OF THE TERTIARY SYSTEM OF BURMA.

Though I have laid down my views with regard to the sub-division of the Tertiary system of Burma in a previous paper[1] it will be useful to recapitulate here the main features, not only because it will serve for a better understanding of the problems here discussed, but chiefly because since the publication of the above paper several new and important facts have been discovered with regard to the sub-division of the *Yenangyoungian*.

Wherever in Burma a complete series of the Tertiary system is developed and well exposed, *two* groups can be recognised and distinguished with the greatest ease. Both differ widely in their faunistic character and, in a broad sense also, in their lithological features, rendering it almost certain that they are of different origin.

The *lower* group is characterised by a *marine* fauna; this character remains unaltered almost throughout the series and only locally undergoes a change by an admixture of rolled fragments of mammalian bones. Lithologically bluish-grey tinges prevail, arenaceous and argillaceous beds alternating, though the former preponderate, and the sediments are decidedly of marine origin, though an estuarine element appears towards the top.

The *upper* group contains chiefly remains of *terrestrial* animals mixed with such forms which according to the habits of their present relatives must have led a *fluviatile* life. Lithologically, yellow, olive-green and sometimes red coloured arenaceous beds prevail; more subordinate are olive-coloured clays in addition to which ferruginous conglomerates of a dull-red or brown colour are not unfrequent. This series must be considered of *fluviatile* origin.

These characters may best be summarised in the following table:—

	Character of Fauna.	Colour of Sediments.	Origin of Sediments.
Upper Group.	Terrestrial and fluviatile.	Yellow, red, olive.	Fluviatile.
Lower Group.	Marine and Estuarine.	Bluish-grey.	Marine.

Notwithstanding this wide difference of the facies of both groups, the upper seems to rest conformably on the lower one. It certainly does so near Yenangyoung or Singu, unless the ferruginous conglomerate, which there forms the basis of the upper group, is regarded as a sign of an unconformity. The late Mr. Grimes[2]

[1] The development and sub-division of the Tertiary system in Burma, Records Geolog. Survey of India, 1895, Vol. XXVIII, page 59 ff.

[2] Mem. Geolog. Survey of India, 1898, Vol. XXVIII, page 43.

claims, however, to have discovered an unconformity between the two groups north of Yenangyat. Though only deduced from the varying thickness of the uppermost beds of the lower group, my own observations with regard to the occurrence of certain fossiliferous horizons led me to almost the same conclusion, though I have refrained from previously expressing a definite opinion, because in a matter of such importance a few isolated observations cannot be considered as decisive. We may now take it as granted that notwithstanding the apparent conformity of beds, a considerable denudation of the lower group took place locally, before the deposit of the upper one. Though locally very extensive, as for instance near Yenangyat, at other places the denudation of the lower group can only have been very small. The fact that locally the denudation was only small seems to be of importance, inasmuch as it proves that the deposit of beds does not appear to have been interrupted for a long time. Further observations are, however, required to confirm this view. I suggest the following names for these two groups:—

2. *Irrawaddi Series* for the upper one, because it is chiefly developed in the broad depression between the Arrakan Yoma in the West and the Shan hills in the East intersected by the river Irrawaddi.

1. *Arrakan Series* for the lower one, because it takes its chief development in the Arrakan Yoma and its outskirts.

1. The Arrakan Series.

According to my observations combined with those of Mr. Theobald the Arrakan Series can again be divided into three sub-divisions, *viz.*, in descending order:—

(*C*) The *Pegu Division.*
(*B*) The *Bassein or Nummulitic Division.*
(*A*) The *Chin Division.*

This sub-division is based on the presence or the absence of the genus *Nummulites*, which occurs in abundance in the middle sub-division, but is entirely absent in the lower and upper one. It will, therefore, be seen that the above subdivision is solely based on palæontological reasons, whether it is also supported by stratigraphical evidence I am unable to say, as I neither observed the contact between *Chin* and *Nummulitic* or the latter and the *Pegu* division.

I can give nothing but the barest outlines of the *Chin* and *Bassein* divisions, because I never had an opportunity of studying them in detail, nor have any collections of fossils been made by previous surveyors. The *Pegu* division is, on the other hand, much better known, because rich collections of fossils have been examined and the sequence of fossiliferous horizons carefully noted.

(*A*) *The Chin Division.*

The name *Chin* division is suggested for this group, because it chiefly occurs in the hills inhabited by the wild Chins.

Dark, flysch-like shales and hard unfossiliferous limestones are the predominating rocks, and it appears that the former chiefly occupy the lower part of the group and are followed by the limestones.

We are perfectly in the dark with regard to the thickness of this division, but it may safely be supposed that it is considerable; so far as it is known, the central part of the Arrakan Yoma is chiefly built up by this series, which forming numerous parallel ridges rises up to over 7,000 feet. No fossils have so far been discovered in this group.

Mr. Theobald's so-called "Axial group" of the southern part of the Arrakan Yoma, and which he considered to be of Triassic age, represents in a broad sense this division, and it is chiefly due to the observations of Mr. Griesbach, who examined that part of the Arrakan Yoma, where the "Axial group" was supposed to be present, that we know that it certainly does not belong to the Triassic, but as Mr. Griesbach thinks, represents the lowest part of the Tertiary system.

The possibility, however, that the *Chin* division in its present delimitation, *i.e.*, including all beds below those containing *Nummulites*, contains Cretaceous beds, if it is not itself of Cretaceous age cannot be denied; in fact, after I had seen the cretaceous system in Baluchistan, I rather felt inclined to consider, if not the whole, at least the shales of the *Chin* division as of cretaceous age.

(*B*) *The Bassein Division.*

Although our knowledge is very scanty with regard to the middle part of the *Arrakan* series we are now on firmer ground, as we have at least some palæontological evidence to guide us.

According to Mr. Theobald the total thickness of the *Nummulitic* or *Eocene* group is 1,223 feet, but to judge from the table given on page 100 of his Memoir, he included at least 227 feet, but probably 500 feet which should belong to the *Chin* division.

Lithologically the lower part of this division consists according to Mr. Theobald of shales and sandstones, occasionally fossiliferous, capped by a bed of highly fossiliferous nummulitic limestone of only 10 feet thickness. This may be the case in the southern part of the Arrakan Yoma; it is, however, quite certain that the calcareous beds increase in thickness in a northern direction.

The fauna discovered in this division appears to be a rich one, but after having sorted Messrs. Theobald and Fedden's collections, it seems that not much time has been devoted towards bringing an exhaustive collection together. So far we know, that it contains several species of the genus *Nummulites*, and in a bed which most probably belongs to the upper part, the well known Eocene species *Velates schmiedeliana*, Chem. sp., has been found.

(*C*) *The Pegu Division.*

The name of Pegu group was proposed by Mr. Theobald "for a very important series of beds intervening between the Eocene or nummulitic division on

the one hand and the fossil wood group on the other." This definition of the *Pegu* division would be very clear and concise if Mr. Theobald had more accurately defined the lower boundary of his fossil wood group. As it is this boundary is very uncertain and I propose to restrict the name of *Pegu* division to that series of beds which rest upon the nummuliferous beds, but are below those containing a terrestrial and fluviatile fauna; they are characterised by a marine fauna which differs from the older one by the total absence of the genus *Nummulites*.

In the above definition the *Pegu* division constitutes a well circumscribed series representing the upper part of the Arrakan series which can be defined as follows:

"Fauna marine, probably of estuarine character in the lower part, of purely marine and sometimes estuarine character in the upper part; glauconitic sandstones of dark green or pepper and salt colour prevail, while argillaceous beds of bluish colour are more subordinate." If the above stratigraphical, faunistic and lithological features are kept in mind, the *Pegu* division is well recognisable all over Burma, though it varies considerably in detail, as can only be expected of a series which presents such an eminent littoral facies. The *Pegu* division can be divided into two parts which are easily to be distinguished when the whole series is exposed, *viz.*—

(*b*) The upper part or *Yenangyoungian*.

(*a*) The lower part or *Promeian*.

The *Promeian* appears to be of an estuarine character both in Upper and Lower Burma. In Lower Burma it seems to be represented by the unfossiliferous series containing coal seams and locally petroleum, occurring below the zone of *Cytherea erycina*; in Upper Burma it is represented by the petroliferous beds of Yenangyoung and the carboniferous series of the Chindwin district.

The *Yenangyoungian* exhibits a quickly changing facies of marine and brackish beds, as will be seen from the detailed description further on.

The difficulties which under these circumstances had to be met, with regard not only to a general sub-division, but also to the correlation of local developments, can readily be understood, and the various horizons which I discerned may be only of purely local character. If it be, however, remembered that this is the first attempt to sift a large amount of material, gathered during the last thirty years, and if further the tremendous climatic difficulties under which the observations had to be carried out, difficulties only those who have penetrated the jungles of Burma can realize, are taken into consideration, a certain allowance will be made for future changes.

(*a*) The Promeian.

1. *Thickness.*—Mr. Theobald describes on pages 83—84 of his Memoir a section of which, unquestionably the lower portion measuring 1,418 feet in thickness, represents the *Promeian*. To this we have to add the thickness of the *Sitsyahn* shales with 800 feet, bringing the total thickness up to 2,200 feet.

At Yenangyoung the drill has gone through rocks belonging to this stage

upwards of 1,000 feet from their upper boundary, without touching the base. At Yenangyat 1,100 feet have been drilled through with the same result. On the right bank of the Chindwin river, I measured a fine section along the Yu river of 3,100 feet of strata belonging to the *Promeian*, without having observed its base, but as numerous pebbles containing Eocene fossils were found in the streams intersecting the lower parts of the section, the boundary cannot have been much further down. It we therefore assume 3,000 feet to be the thickness of the *Promeian* we are rather under than above the mark.

2. *Lithological characters.*—The chief constituents are sandstones and clays; the latter are, however, subordinate to the former, accessory are coal seams and ironstones; locally the sandstone contains petroleum, and at two or three localities the fossil resin Burmite. The sandstone is of very uniform character, it is finely grained and generally of a greyish colour which may best be styled "pepper and salt colour." Its hardness varies considerably, sometimes it is soft and friable, sometimes siliceous and very hard. A curious instance of weathering may often be noticed along the banks of the Irrawaddi or the Chindwin; the sandstone disintegrates into rather regular lumps which retain their original position for a long time, thus imitating a street pavement.

The clay is still more monotonous in its character as it is usually a tough clunch of bluish colour, but the argillaceous beds are of much smaller importance in the composition of the series than the arenaceous ones.

The coal occurs in seams of small thickness, but it would exceed the limits of this summary if I were to dwell at length on its occurrence. The same applies to the Petroleum and Burmite, but anybody interested in these subjects will find ample information in my previous papers.

3. *Palæontological characters.*—The *Promeian* has hitherto yielded only a few fossils occurring close towards its top at Yenangyoung; otherwise it appears to be absolutely unfossiliferous, though it is certain that remains of plants will sooner or later be discovered.

4. *Sub-division.*—It is obvious that under these circumstances a further subdivision is almost an impossibility, and this will remain so, until some fossiliferous horizons are discovered. At Yenangyat and Yenangyoung the *Promeian* is only known from bore holes, and the evidence relating to a general sub-division is very unsatisfactory. We know that there exists a series of alternating arenaceous and argillaceous beds of bluish colour, the former charged with petroleum, but for want of any palæontological evidence no sub-division was even attempted; in fact, the lithological change seems so rapid and unexpected, that I had the greatest difficulty in correlating the sections of the single bore holes. The zone of *Anoplotherium birmanicum* which occurs close to the top is the only fossiliferous horizon which could be distinguished, and even this is apparently of very local occurrence only.

(*b*) The Yenangyoungian.

1. *Thickness.*—There are some good and reliable observations with regard to the thickness of this group. At Yenangyat I measured a thickness of 1,200 feet; at

Singu I found it only 700 feet, but the late Mr. Grimes measured 2,450 feet, three miles south of Singu.[1] At Yenangyoung its thickness was found to be 1,100 feet. As these data are founded on reliable measurements, it is almost certain that the thickness of the Yenangyoungian undergoes considerable changes within a distance of about 50 miles in a straight line, but whether these differences are due to denudation of its upper part, or to the unevenness of the surface of the *Promeian* I am unable to say. It is certain that part of it is due to the first cause, but the second one cannot be entirely improbable.

The data regarding the thickness of this sub-division in lower Burma are much less reliable; it is unquestionable that the topmost 514 feet of Mr. Theobald's section belong to the *Yenangyoungian*, but to this we have to add (*a*) the thickness of beds below the Kama clay, (*b*) the Kama clay, and (*c*) all that "very thick" series of beds between the Kama clay and the Fossil wood group. It is extremely difficult to form an estimate, but if we assume *a*—*b* to be 500 feet, and that of (*c*) to be 1,000 feet, we obtain a total thickness of about 2,000 feet, which estimate is probably rather under than above the mark.

2. *Lithological characters.*—The strata developed are of the same composition as those of the *Promeian, viz.*, sandstones and clays; but there is a distinct change of colour at least in such places where the brackish facies is developed. In the latter case olive tinges prevail, while in the marine facies the dark green or dark blue colours will be observed. A remarkable feature is the occurrence of gypsum which is often found in large crystals. So far this mineral has not been observed in the *Promeian*, neither has it been found in the marine facies of the *Yenangyoungian.* Its presence is therefore almost sure to denote the brackish facies of the *Yenangyoungian.*

3. *Palæontological characters.*—The *Yenangyoungian* has so far yielded almost all the fossils described in the following pages, and as they will be discussed in detail later on, it is needless to dwell here on this subject.

4. *Facial development.*—In upper Burma the *Yenangyoungian* is developed in two distinct facies, *viz.*, a marine facies and a brackish facies, an observation about which there can be not the slightest doubt, as owing to good exposures and correct maps it could be proved to a certainty that a marine fauna occurs at Singu and Yenangyat in the same level, in which at Yenangyoung an estuarine fauna occurs. In fact, if more time could be spent, the gradual passage from estuarine to marine beds could be easily traced.

The *marine* facies which contains a rich fauna is chiefly exposed in the Yenangyat anticlinal between Singu, Yenangyat and near Minbu; dark green, very glauconitic hard sandstones are prevailing; more subordinate are layers of dark olive colour.

The *brackish* facies is almost unfossiliferous except for three species of the genus *Cyrena* which occur locally towards its top. It is generally composed of olive coloured clays, containing gypsum; layers of hard concretionary sandstone are frequently intercalated. This facies is particularly well developed near

[1] Mem. Geolog. Survey of India, 1898, Vol. XXVIII, page 41.

Yenangyoung, where it attains a thickness of 1,100 feet; at Minbu, Singu and Yenangyat its thickness is considerably reduced, as its place is almost entirely occupied by the marine facies.

With regard to lower Burma it is impossible to say at present whether both the marine and brackish facies are developed. The marine facies is unquestionably well represented, as is proved by the fine collections of marine fossils, but I have no evidence to say whether estuarine beds occur or not.

5. *Sub-division.*—There is a great difficulty with regard to the sub-division of the brackish facies, and no attempt has been made to sub-divide the monotonous series of unfossiliferous beds. Only at the very top of the series a few species of *Cyrena* appear, which though occurring locally only, form the very characteristic horizon of *Cyrena* (*Batissa*) *crawfurdi* near Yenangyoung. On the other hand, we are much better off with regard to the marine facies of which the vertical sequence of the different horizons has been ascertained by actual observation. In descending order the following horizons could be distinguished :—

Marine facies.	Estuarine facies.
6. Zone of *Cardita tjidamarensis*, K. Martin.	1. Zone of *Cyrena* (*Batissa*) *crawfurdi*, Noetling.
5. Zone of *Mytilus nicobaricus*, Chemnitz.	
4. Zone of *Meiocardia metavulgaris*, spec. nov.	
3. Zone of *Dione dubiosa*, Noetling.	
2. Zone of *Cancellaria martiniana*, spec. nov.	
1. Zone of *Paracyathus caeruleus*, Duncan.	

It must, however, be mentioned that it is not quite certain whether the zone of *Cyrena* (*Batissa*) *crawfurdi* is really correlated to the zone of *Cardita tjidamarnesis*; in fact, there are reasons to believe that it is perhaps equivalent to the zone of *Mytilus nicobaricus*.

In lower Burma the following horizons could be distinguished ;—

Marine facies.

7. Zone of *Turritella acuticarinata*, Dunker.
6. Zone of *Ostrea peguensis*, spec. nov. (?) Zone of *Ostrea promensis*, spec. nov. (?)
5. Zone of *Arca theobaldi*, spec. nov.
4. Zone of *Parallelipipedum prototortuosum*, spec. nov.
3. Zone of *Pholas orientalis*, Gmelin.
2. Zone of *Aricia humerosa*, Sowerby, spec.
1. Zone of *Cytherea erycina*, Favanne.

2. The Irrawaddi series.

The *Irrawaddi* series comprises all that enormous thickness of strata which rests on the marine Tertiary beds and which is characterised by a purely terrestrial and fluviatile fauna; in addition to which it contains large quantities of silicified wood. So far no well defined sub-divisions could be distinguished, because the lithological character is very monotonous, and though fossils have been found, they occur only locally, thus rendering the tracing of a given horizon over a larger distance an impossibility.

(*A*) *Thickness.*

The *Irrawaddi* series, as above circumscribed, exhibits a measured thickness of 4,620 feet in the neighbourhood of Yenangyoung, but this appears to be only a small part of the total thickness. The fine cross out of the Irrawaddi, between Singu and Salemyo, affords an almost complete section of the *Irrawaddi* series from their base, to probably within a short distance of its uppermost beds, and the thickness thus calculated would not be less than 20,000 feet. This will probably represent its maximum thickness, and it appears that in lower Burma the Irrawaddi series is much less developed than in upper Burma.

(*B*) *Lithological Characters.*

The rocks which compose the *Irrawaddi* series form by their light tinges a most marked contrast to the dark-coloured beds of the *Arrakan* series. Light yellow is the prevailing colour, but dull red, brown and olive-green tinges are by no means rare, though they take only a subordinate rank.

The predominant rock is a very soft sandstone which might perhaps better be termed "sand rock" of light-yellow colour. It is deposited in thick beds which frequently contain nodular or kidney-shaped concretions of extremely hard siliceous sandstone. These concretions, sometimes of considerable size, are arranged in strings, parallel to the bedding and stick out of the surrounding softer material, thus forming a very characteristic feature in the landscape. Alternating with the sandstone are beds of light olive coloured clay, which, however, never attain the thickness of the sandy beds. Still more subordinate are bands of ferruginous conglomerate; in these beds foreign matter is sometimes so rare that they form regular layers of cellular iron ore, which has in former times been used for iron smelting. Their thickness changes from a few inches upwards to 15 feet, but except the basal conglomerate, they form most irregular, lenticular masses of often no more than a few feet in length.

(*C*) *Palæontological Characters.*

The *Irrawaddi* series contains numerous remains of terrestrial and fluviatile animals, but so far I have not been able to discover whether they are generally distributed throughout the series, or whether they are confined to certain localities only. It is, however, a fact that they occur in the conglomeratic beds in preference to all others, but even there the distribution is very erratic. The number of species so far discovered amounts to about 30, but except for a preliminary determination they have not been further examined.

In addition to the animal remains numerous fragments of silicified wood, often of considerable size, occur throughout the series; no examination of these fossil remains has hitherto been undertaken, but it appears that monocotyledonous species preponderate.

(*D*) *Sub-division.*

There have been several attempts of sub-dividing this enormous series; but whether they can claim more than local importance remains to be seen.

Mr. Theobald distinguishes in lower Burma the following three groups in descending order :—

3. Fossil wood sands,
2. Fine silty clay,
1. Mogoung sands,

but it is certain that this sub-division does not hold any good outside the limited area around Thayetmyo and Prome. The late Mr. Grimes[1] based his sub-division also on lithological differences only; he distinguishes in descending order :—

4. Sandstones with ferruginous conglomerate and much fossil wood.
3. Sandstones with numerous small, root-like concretions and little fossil wood.
2. Sandstones with large rounded concretions and much fossil wood.
1. Sandstones with numerous bands of ferruginous conglomerate containing vertebrate remains.

As I thoroughly know the country around Yenangyoung for which this sub-division has been established, I can confidently say that in the above delimitation it holds good on paper only, but is useless for all practical purposes. Even if it were possible to recognise the sub-division for the country around Yenangyoung, I am sure that it would be futile to adopt it, say for the country north or south of this village. I think it a mistake to attempt the sub-division of this monotonous series of arenaceous beds on lithological differences only.

The only instance of a particular bed of the *Irrawaddi* series being traced over a larger distance seems to be the basal conglomerate, but even this appears to split up north of Yenangyat, and Mr. Grimes felt inclined to include in this zone the next 150 to 200 feet of sandstone, containing bands of conglomerate, a view which I by no means approve of. I still hold that a sub-division based on palæontological evidence, however incomplete that may be, deserves preference to any other based on lithological differences only, and I do not see any reason why I should alter the preliminary sub-division as suggested by me[2] unless better palæontological evidence should be forthcoming.

In descending order I divide the *Irrawaddi* series into the following sub-divisions :—

(*b*) *Upper Irrawaddi series.*—Yellow, soft and friable sandstones, alternating with beds of brown clay. No fossil bones. Fossil wood not very common.

(*a*) *Lower Irrawaddi series.*

2. Zone of *Mastodon latidens* and *Hippopotamus irravadicus*. Yellow, soft and friable sandstones, alternating with conglomeratic beds, containing numerous fossil bones; brown clays; fossil wood very common.

[1] Mem. Geolog. Survey of India, 1898, Vol. XXVIII, page 62.
[2] Records Geolog. Survey of India, 1895, Vol. XXVIII, page 85.

1. Zone of *Hippotherium antelopinum* and *Acerotherium perimense*. A ferruginous conglomerate containing numerous fossil bones, which forms the base of the series.

I confess that this sub-division is only a preliminary one, inasmuch as the three groups are of very unequal value. In fact, it is difficult to say, chiefly on account of the erratic occurrence of the fossil bones, where the lower sub-division ends and the upper one commences; but until more time can be spent in an extensive examination of the *Irrawaddi* series, our knowledge must necessarily remain insufficient. In the following tabular view I arranged the sub-division of the Tertiary system as detailed in the above pages in such a way that the plan adopted can be seen at a glance. The table will explain itself and nothing need be said except that the value of the different sub-divisions must necessarily be very different, inasmuch as our present knowledge of the Tertiary fauna is a very small one, and almost chiefly limited to the study of the fossils of the *Yenangyoungian*.

Character of Fauna.		Character of Sediments.		Name of Series.	Name of Division.	Name of Sub-division.	Thickness.		European Equivalents.
Terrestrical and Fluviatile.		Yellow Sandstone.		Irrawaddi Series.	Upper Irrawaddi Series.	Not sub-divided.	20,000 feet.		Pliocene.
					Lower Irrawaddi Series.	Not sub-divided.			
Marine.	No Nummulites.	Marine facies, bluish-green glauconitic sandstone.	Brackish facies, olive-coloured clays with gypsum.	Arrakan Series.	Pegu Division.	*Yenangyoungian.*	2,450 feet.	5,500 feet.	Miocene.
		Bluish-green, glauconitic sandstone.	Bluish-grey pepper and salt coloured sandstone.			*Promeian.*	3,100 feet.		
	Nummulites.	Limestone and shales.			Bassein Division.	Not sub-divided.	1,200 feet.		Eocene.
	No Nummulites	Limestone and shales.			Chin Division.	Not sub-divided.	More than 10,000 feet.		Eocene (?) Cretaceous (?)

II.—CORRELATION OF THE BURMESE TERTIARY SYSTEM WITH THE EUROPEAN TERTIARIES.

It will be seen from the foregoing pages that in Burma the Tertiary system exhibits a development which is widely different from that of Europe. If Tertiary Geology had first been started in India, we would have arrived at totally different views regarding this formation, and the name of "Dyas" on account of its pronounced bi-division would perhaps have been chosen. It is obvious that under the above circumstances any correlation with the European Tertiaries can only be carried out in the broadest sense possible. Every attempt to go into details, or to recognise smaller European divisions in the Burma facies of the Tertiary system, must result in a failure. The development this formation has taken in Burma is so totally different from that of Europe, faunistically as well as stratigraphically, that we have almost no lines to guide us in its interpretation, and we are obliged to refrain from any correlation with the now recognised sub-division of the Tertiary system in Europe, except on the broadest lines. To arrive at an idea of the relative age of the various sub-divisions of the Burma Tertiary system we have three distinct faunas, succeeding in vertical direction, these are in descending order—

3. The terrestrial and fluviatile fauna of the *Irrawaddi* series.
2. The marine fauna of the *Pegu* division.
1. The marine fauna of the *Bassein* division.

Though the most important conclusions could be deduced from the study of these faunas, we meet almost at once with a great difficulty; we have no continuous development of a marine fauna; in fact it is almost certain that the upper marine and the terrestrial fauna did not immediately succeed each other, but were separated by an unconformity the period of which lasted differently at different localities. The deductions, drawn from the study of the vertebrate fauna, must certainly be at variance with those drawn from the study of the invertebrates, and both are therefore not comparable. We will presently see that the fauna, which exists in the *Pegu* division, contains a large percentage of species, which live now-a-days in the Indian Ocean; yet this fauna is buried underneath a series of strata measuring rather more than 20,000 feet in thickness. During the time of its deposit the vertebrate fauna underwent tremendous changes, if compared with the same fauna now inhabiting Burma, while, on the other hand, the much older marine fauna exhibits such a comparatively small change, that during the time which passed since the beginning of the *Pegu* division, one-third of the species have completely preserved their original character.

Whatever results we may therefore deduce from the study of the vertebrate fauna of the *Irrawaddi* series, there will always be the unsurmountable difficulty in bringing such evidence in harmony with that derived from the study of the invertebrates of the older strata. This view holds good even if the fauna of the *Irrawaddi* series were better known than it is at present. I made a goodly

collection near Yenangyoung; Mr. Grimes found some good specimens near Sinbu; those collected by Messrs. Theobald and Oldham were determined by Mr. Lydekker, but unfortunately I have not found time yet to examine these collections thoroughly, and except the preliminary determinations we know nothing about the fauna of the *Irrawaddi* series.

These determinations have, however, proved one thing to a certainty, that the *Irrawaddi* series must be correlated to the Siwaliks of India. It would be out of place to roll up the question of the age of the Siwaliks, but I think with Mr. Oldham[1] that the balance of evidence is more in favour of the Pliocene age.

With regard to the fauna of the *Pegu* division, we can at once say that it has not a single species in common with any European Tertiary fauna. There are indications to prove that the Eocene fauna of France exhibits some relations with the fauna of the *Pegu* division, but these do not go further than general similarities. As the fauna of the *Pegu* Division will be discussed in detail in a subsequent chapter it is sufficient to say here that it cannot be compared to any European Tertiary fauna, but that it bears a close relationship to the fauna inhabiting at present the Indian Ocean. For the purposes of correlating the *Pegu* division to any of the sub-divisions of the Tertiary system as recognised in Europe, its fauna is therefore perfectly useless.

If we now turn to the fauna of the *Bassein* division we are still worse off than with regard to that of the *Irrawaddi* series; the collections are comparatively small and by no means well preserved; they chiefly consist of *Nummulites* and a few other fossils, but not even a preliminary determination has been carried out. We know that *Velates schmiedeliana*, Chemn. sp., occurs in the upper part of this division, but except that fact, and that the genus *Nummulites* is very common, we know nothing with regard to its fauna. Poor as these few facts may be, they enable us, however, to form a definite view with regard to the position the *Bassein* division holds in the sequence of the Tertiary system.

The genus *Nummulites* is the typical Eocene fossil; at least there is no instance on record that it occurs in abundance in any but the Eocene formation. This is a sufficiently recognized fact on which I need not dwell any longer. We are therefore fully justified in assuming that the *Bassein* division, with its rich fauna of species belonging to the genus *Nummulites*, corresponds to the Eocene period of Europe, and if we further take the limited vertical distribution of *Velates schmiedeliana* into consideration, we may suppose that the *Bassein* division can be correlated to the Upper Eocene, and is most probably equivalent to the *Khirtharian* of Western India and Baluchistan.

We have now gained a firm basis, starting from which we may draw certain conclusions with regard to the older and younger strata. The whole series resting on the *Bassein* division must necessarily represent the younger Tertiaries, that is to say, upwards of the *Bartonian* of the European geologists. The fauna of the *Irrawaddi* series renders it almost certain that it must be correlated to the Pliocene age; the *Pegu* division would therefore necessarily represent the *Miocene* period.

[1] Manual of the Geology of India, 2nd ed., 1893, page 341.

With regard to the lower sub-division of the *Arrakan* series, the *Chin* division, we can only say at present that it must be older than upper eocene, or the *Khirtharian* of Western India. But whether it corresponds to the *Ranikotian* in its whole extension, or only its upper part, while the lower one may probably be of upper Cretaceous age, we are unable to say for the present, and the decision must be left to the future.

The above argumentation has therefore led to the result that the *Irrawaddi* series represents the Pliocene period, while the *Arrakan* series, with probably the exception of its lowest part, represents the Eocene and Miocene.

I have purposely refrained from mentioning the Oligocene; if we keep in mind for what series of strata the Oligocene has originally been established in Northern Germany,[1] it seems almost absurd to try and recognize this division of the Tertiaries, which is so eminently a facies of the European continent, in Burma. I am fully in concordance with Professor Dr. Martin, that no evidence warrants the adoption of this name for any part of the Indian Tertiary system whether it be in Baluchistan, Western India, Burma, Java, Sumatra or Borneo. We have, as I repeatedly pointed out, a few meagre facts to correlate certain strata with the Eocene of Europe, but palæontological evidence holds no longer good with regard to the marine beds resting on those which we consider as Eocene. The only fact we know is, that they must be younger than Eocene, and the natural conclusion is that we consider them as the representatives of the Miocene period, but to correlate any part of them to the Oligocene would mean assuming a view which cannot be supported by any palæontological evidence.

III.—THE MIOCENE OF BURMA.

1.—DEVELOPMENT AND SUB-DIVISION.

(*A*)—*Lower Burma; Prome and Thayetmyo.*

(*a*) GENERAL REMARKS.

Messrs. Theobald and Fedden's collections have been chiefly made in this part of Burma, but having had no opportunity myself of examining the Tertiary system in lower Burma, except by such observations as could be made by rapidly passing through the country, I have solely to depend with regard to the stratigraphical features on Mr. Theobald's memoir.

Mr. Theobald divided his *Pegu* group, which corresponds to my *Pegu* division, into two sub-divisions, *viz.*:—

2. *Prome* beds.
1. *Sitsyahn* shales.

[1] Beyrich, Abhandl. der koenigl. Akademie der Wissensch. Berlin, 1856.

The lower *Sitsyahn* shales are according to Mr. Theobald unfossiliferous, and the fossils collected by him come therefore all from the *Prome* beds, and if I am correct in my interpretation, they must all come from the upper part of the *Prome* beds, that is to say, from Mr. Theobald's group B, the lower group A being unfossiliferous.

After carefully sorting his collections, and rejecting all doubtful specimens, six horizons, well characterised by different lithological and palæontological features, could be distinguished, but as no information had been left as to the relative vertical position of these beds, I was absolutely in the dark with regard to their sequence.

The section given on pages 83 and 84 of Mr. Theobald's memoir, as well as a few stray remarks scattered here and there, helped materially in solving this problem, and though I am still not quite certain as to the position of some of them, the position of the more important horizons has been fairly well fixed.

On page 84 Mr. Theobald states that the upper of the two groups into which he has divided the *Prome* beds, begins with "compact marly sandstone, softer at base," which contains "*Cardita*" and "*Cytherea*." There can be no doubt that this bed represents the horizon frequently mentioned by Mr. Theobald as *Cytherea promensis*-bed, because one of the chief characteristics of this horizon is the large number of the two species, *Cytherea erycina* and *Cardita protovariegata*. As I have proved that *Cytherea promensis*, Theob., is identical with the living *Cytherea erycina*, Fav., the horizon which I styled zone of *Cytherea erycina* is represented by this bed, which would thus occur 1,418 feet, plus 800 feet, the thickness of the *Sitsyahn* shales=2,200 feet, above the base of the *Pegu* division.

I have not been able to identify any of the other two fossiliferous horizons, mentioned in the enumeration of the beds composing Mr. Theobald's group B, but the position of two other horizons, important on account of the rich and well preserved fauna they contain, has again been fairly well fixed. Mr. Theobald writes on page 85 as follows: —

"The channel of the Irrawaddi here intervenes causing a break between the section above given and its continuation on the opposite bank . . . . The most important beds in the section, however, which I think must intervene at this place, are some very fossiliferous blue shales which . . . . I have termed Kama clay."

This is a very precise and clear statement, and we must therefore conclude that the fauna of the Kama clay is younger than that of the zone of *Cytherea erycina*, and occurs perhaps 1,000 ft. above it.

When examining the collections labelled "Kama," it became at once evident that there were two lithologically, and as it afterwards proved, also palæontologically, different horizons. One of the beds is a soft, yellow sand, hardly argillaceous, in which the shells are simply bleached; the other is a bluish green argillaceous sand, in which the fossils have a slightly reddish tinge. After a little practice it is impossible to mistake the fossils, even if they should have become mixed.

If we assume that the bluish sand represents the Kama shales properly speaking, the position of the yellow, arenaceous horizon is doubtful so far, as it cannot be stated whether it occurs above or below the former one. Certain palæontological reasons, of which I shall speak more later on (pages 137 and 138) have, however, led me to believe that the yellow sand is older than the bluish one. I styled the former zone of *Parallelipipedum prototortuosum*, and the latter the Kama shales properly, zone of *Arca theobaldi*, and these horizons would occur about 3,300 feet above the base of the *Pegu* division.

There are, however, three or perhaps four more fossiliferous horizons which I designated zone of *Ostrea peguensis*, zone of *Ostrea promensis*, zone of *Pholas orientalis*, and zone of *Aricia humerosa*, the position of which can only be guessed.

The first two zones, that of *Ostrea peguensis* and *Ostrea promensis*, represent *Ostrea*-beds, probably exclusively built up of the shells of these species, but as neither species has been found in any other horizon, we are perfectly in the dark as to their position; they may occur anywhere between the zone of *Cytherea erycina* and *Turritella acuticarinata*, though perhaps it is probable, for reasons further explained, that they occur above the zone of *Arca theobaldi*. There are a few, though very faint, indications with regard to the position of the remaining two horizons; both are represented by a dark green, very glauconitic sandstone, and as a considerable number of species occurring in both horizons are common with the fauna of the zone of *Cytherea erycina* and that of the zones of *Parallelipipedum prototortuosum* and *Arca theobaldi*, I assume both horizons to hold an intermediate position between that of *Cytherea erycina* and the other two zones. This view is further strengthened by Mr. Theobald's section, according to which no fossiliferous horizons occur below the bed containing *Cytherea* and *Cardita*, but no definite position can, however, be assigned to them; we must therefore leave it an open question, in which part of the 514 feet above the zone of *Cytherea erycina* they occur.

"Above the Kama shale occurs a very thick series of sandstones and shales, which do not present any bed sufficiently well marked, either by mineral character or fossil contents, to serve as a serviceable horizon for the division of the group. (Theobald, *l. c.*, page 86.) There are some slight means, however, of judging the position of some of the highest beds of the present group, as, for instance, the occurrence of a species of '*Turritella*,' hardly distinguishable from one now living on the coast, which seems, where it occurs plentifully, to mark a high position in this group." (Theobald, *l. c.*, page 87.)

From these remarks we may suppose that the most important fossiliferous horizons near Thayetmyo and Prome are restricted to the middle part of Theobald's *Pegu* group as represented by group B of his *Prome*-beds, and that above the zone of *Arca theobaldi*, only a few fossiliferous horizons occur, among which are perhaps the *Ostrea*-beds, and one containing numerous specimens of a *Turritella*.

(*b*) Detailed description.

1. The *Sitsyahn* shales.—"The base of the Pegu group would appear to consist

of a thick deposit of shales, with a little sandstone very subordinately developed . . . . . The Sitsyahn shale is a blue, somewhat clunchy clay, with very little appearance of bedding save towards its upper portion where sandstone courses begin to come in . . . . . . It is, as far as I know, entirely unfossiliferous, and along the long expanse of this shale below Sitsyahn, I failed to detect the slightest trace of any organism whatsoever . . . . . . No estimate can be formed of the entire thickness of this lower division of the group; but I think that close on 400 feet are here (*viz.*, near Sitsyahn) seen, and probably twice that amount would not be an over-estimate for the entire thickness of this division." (Theobald, *l. c.*, pages 81 and 82.)

2. *Prome*-sandstone.—Above the *Sitsyahn* shales follows a series of chiefly arenaceous beds with subordinate layers of clays. According to Theobald the sandstones are of grey colour, but no mention is made of any fossiliferous horizon in his section on page 83, and the inference that this group is unfossiliferous would therefore be fully justified. If this be the case, and we have at present no further proofs contradicting this view, it is perhaps probable that the lower part of the Miocene near Prome and Thayetmyo is unfossiliferous and equivalent to the unfossiliferous series containing the petroleum in upper Burma. The development of the Miocene in lower and upper Burma would therefore be exactly alike, but further proofs are of course required.

3. Zone of *Cytherea erycina*, Favanne.—The lowest known fossiliferous horizon is a bed of compact marly sandstone, of five feet thickness, forming the base of Mr. Theobald's group B. The sandstone is rather hard and almost entirely built up of shells of *Cytherea erycina* and *Cardita protovariegata*, both species having almost always the two valves united. Other species are much less common, except perhaps *Ceratotrochus alcockianus*. The following is the list of fossils described from this bed :—

1. *Ceratotrochus alcockianus*, spec. nov.
2. *Flabellum distinctum*, Milne Edwards.
3. *Pecten kokenianus*, spec. nov.
4. *Cardita protovariegata*, spec. nov.
5. *Cytherea erycina*, Favanne.
6. *Dione protolilacina*, spec. nov.
7. ,, *protophilippinarum*, spec. nov.
8. *Dosinia protojuvenilis*, spec. nov.
9. *Tellina grimesi*, spec. nov.
10. *Trochus*, sp.
11. *Vermetus javanus*, K. Martin.
12. *Natica callosa*, Sowerby.
13. ,, *obscura*, Sowerby.
14. *Sigaretus neritoideus*, Linné.
15. *Ranella elegans*, Beck.
16. *Eburna protozeylanica*, spec. nov.
17. *Pyrula pugilina*, Born. spec.
18. *Ancillaria cf. vernedei*, Sowerby.
19. *Subula spec.*

20. *Conus avaënsis*, spec. nov.
21. *Balanus tintinnabulum*, Linné.

4. Above the zone of *Cytherea erycina* follows a series of beds measuring according to Mr. Theobald, 541 feet in thickness, which contain several fossiliferous horizons. As the *Sitsyahn*-shales and the *Prome*-sandstone are apparently unfossiliferous, I do not think that I am wrong if I attribute the following two zones a place in this series, though it must be left to future researches to find out their proper position, and to decide which of the two is the older one.

4*b*. Zone of *Pholas orientalis*, Gmelin.—This zone is represented by a hard quartzitic sandstone of very dark-green or brown colour; the shells are generally snowy white, and shine out brilliantly against the surrounding matter; they are, however, generally not well preserved, and mostly strongly weathered, particularly the pelecypodan shells. The most common species is *Pholas orientalis*, Gmelin, while the other species are known only by a few specimens. The following is the list of species described from this bed:—

1. *Flabellum distinctum*, Milne Edwards.
2. *Pecten kokenianus*, spec. nov.
3. *Pinna spec.*
4. *Arca oldhamiana*, spec. nov.
5. " *bataviana*, K. Martin.
6. " *peethensis*, d'Archiac and Haime.
7. *Cardita planicostata*, spec. nov.
8. *Meiocardia protovulgaris*, spec. nov.
9. *Petricola incerta*, spec. nov.
10. *Venus protoflexuosa*, spec. nov.
11. *Cytherea erycina*, Favanne.
12. " *yomaënsis*, spec. nov.
13. *Dione protolilacina*, spec. nov.
14. " *amygdaloides*, spec. nov.
15. " *protophilippinarum*, spec. nov.
16. *Tellina grimesi*, spec. nov.
17. " *foliacea*, Reeve.
18. " *hilli*, Noetling.
19. *Solen spec.*
20. *Mactra protoreevesii*, spec. nov.
21. *Corbula socialis*, K. Martin.
22. *Pholas orientalis*, Gmelin.
23. " *blanfordianus*, spec. nov.
24. *Solarium nitens*, spec. nov.
25. *Calyptraea rugosa*, Noetling.
26. *Natica obscura*, Sowerby.
27. *Ancillaria cf. vernedei*, Sowerby.
28. *Conus avaënsis*, spec. nov.

4*a*. Zone of *Aricia humerosa*, Sowerby, spec.—Lithologically this zone is characterized by bright green, fairly hard sandstone, the fossils are generally well

preserved, but exhibit a peculiar reddish or ochre tinge. The following is the list of fossils described from this bed :—

1. *Flabellum distinctum*, Milne Edwards.
2. *Spondylus spec.*
3. *Lima griesbachiana*, spec. nov.
4. *Pecten kokenianus*, spec. nov.
5. *Cardita viquesneli*, d'Archiac and Haime.
6. „ *planicostata*, spec. nov.
7. *Crassatella rostrata*, Lamarck.
8. *Cardium protosubrugosum*, spec. nov.
9. „ *minbuense*, spec. nov.
10. *Dione amygdaloides*, spec. nov.
11. „ *protophilippinarum*, spec. nov.
12. *Dosinia protojuvenilis*, spec. nov.
13. *Tellina grimesi*, spec. nov.
14. „ *foliacea*, Reeve.
15. „ *hilli*, Noetling.
16. *Solarium coniforme*, spec. nov.
17. *Vermetus javanus*, K. Martin.
18. *Xenophora birmanica*, spec. nov.
19. *Calyptraea rugosa*, Noetling.
20. *Natica callosa*, Sowerby.
21. „ *obscura*, Sowerby.
22. *Arcia humerosa*, Sowerby spec.
23. *Ranella elegans*, Beck.
24. *Fusus verbecki*, K. Martin.
25. *Oliva rufula*, Duclos.
26. *Ancillaria cf. vernedei*, Sowerby.
27. *Subula spec.*
28. *Conus literatus*, Linné.
29. „ *avaënsis*, spec. nov.
30. „ *yuleianus*, spec. nov.
31. *Balanus tintinnabulum*, Linné.

5. If I correctly interpret Mr. Theobald's view, he thinks that above the section described on pages 83 and 84, but below the Kama clay there follows a series of beds which are hidden by the Irrawaddi, in other words, the Kama clay does not succeed immediately on the top of the last bed mentioned in his section. The thickness of these beds, supposed to be 500 feet,[1] will be rather below than above the mark.

6. Zone of *Parallelipipedum prototortuosum*, spec. nov.—This zone is represented by a very soft, finely grained sand-rock of yellow colour, which, when soaked with water, easily crumbles away. Nothing definite is known about the thickness or exact position of this zone, though palæontologically it represents one of the most important ones of the whole series. The fossils are beautifully preserved, but, what is remarkable, with a few exceptions, the Pelecypoda are much better preserved

[1] The breadth of the Irrawaddi between Prome and the opposite bank is almost a mile.

than the Gastropoda. The shells almost resemble living ones, picked up on the sea-shore, only that they have lost their colour.

The most characteristic species is ***Parallelipipedum prototortuosum***, a species which has not been found in any of the other beds. The following is the list of fossils described from this bed, and though it contains the largest number of species, I have not the slightest doubt that it is not exhaustive, and future researches will probably considerably swell the number :—

1. *Ceratotrochus alcockianus*, spec. nov.
2. *Flabellum distinctum*, Milne Edwards.
3. *Paracyathus caeruleus*, Duncan.
4. *Cidaris spec.*
5. *Ostrea papyracea*, spec. nov.
6. *Pecten kokenianus*, spec. nov.
7. *Vulsella lingua-tigris*, spec. nov.
8. *Arca burnesi*, d'Archiac and Haime.
9. „ *yawensis*, spec. nov.
10. „ *peethensis*, d'Archiac and Haime.
11. *Parallelipipedum prototortuosum*, spec. nov.
12. *Nucula phayreiana*, spec. nov.
13. *Leda avaënsis*, spec. nov.
14. *Cardita protovariegata*, spec. nov.
15. „ *viquesneli*, d'Archiac and Haime.
16. *Lucina neosquamosa*, spec. nov.
17. „ *pagana*, spec. nov.
18. *Cardium protosubrugosum*, spec. nov.
19. „ *minbuense*, spec. nov.
20. *Meiocardia protovulgaris*, spec. nov.
21. *Cytherea erycina*, Favanne.
22. *Dione protolilacina*, spec. nov.
23. „ *arrakanensis*, spec. nov.
24. „ *amygdaloides*, spec. nov.
25. „ *protophilippinarum*, spec. nov.
26. *Dosinia protojuvenilis*, spec. nov.
27. *Tellina grimesi*, spec. nov.
28. „ *protostriatula*, spec. nov.
29. „ *protocandida*, spec. nov.
30. „ *indifferens*, spec. nov.
31. „ *foliacea*, Reeve.
32. „ *hilli*, Noetling.
33. „ *pseudohilli*, spec. nov.
34. *Gari natensis*, spec. nov.
35. „ *protokingi*, spec. nov.
36. *Hiatula textilis*, spec. nov.
37. *Mactra protoreevesi*, spec. nov.
38. *Corbula socialis*, K. Martin.
39. *Dentalium junghuhni*, K. Martin.
40. *Solarium maximum*, Philippi.
41. *Scalaria birmanica*, Noetling.
42. *Turritella simplex*, Jenkins.

43. *Turritella acuticarinata*, Dunker.
44. " *leiopleurata*, spec. nov.
45. " *lydekkeri*, spec. nov.
46. " *spec.*
47. *Vermetus javanus*, K. Martin.
48. *Natica callosa*, Sowerby.
49. " *obscura*, Sowerby.
50. " *gracilior*, spec. nov.
51. *Sigaretus neritoideus*, Linné.
52. *Ficula spec.*
53. *Ranella oprtotuberculris*, spec. nov.
54. " *elegans*, Beck.
55. *Oliva rufula*, Duclos.
56. *Clavatella munga*, spec. nov.
57. *Conus avaënsis*, spec. nov.
58. " *yuleianus*, spec. nov.
59. " *hanza*, spec. nov.
60. " *protofurcus*, spec. nov.
61. *Ringicula turrita*, K. Martin.
62. *Balanus tintinnabulum*, Linné.
63. *Callianassa birmanica*, spec. nov.

7. Zone of *Arca theobaldi*, spec. nov.—For reasons stated above I think that this zone represents the true Kama clay of Mr. Theobald; the matrix in which the fossils are contained is a bluish-green arenaceous clay, which readily crumbles away in water. The shells are quite as well preserved as in the Zone of *Parallelipipedum prototortuosum*, though perhaps not with the same sharpness and clearness of detail.

The most common species is *Arca theobaldi*, and chiefly on account of this species I attributed a higher position to this bed than to the zone of *Parallelipipedum prototortuosum*. *Arca theobaldi* is so closely related to *Arca burnesi*, one of the most common species of the zone of *Parallelipipedum prototortuosum*, that at the first glance it might be mistaken for that species; on closer examination it will, however, be found that, while in *Arca burnesi* only the left valve exhibits a certain ornamentation, the same ornamentation occurs on both valves in *Arca theobaldi*; assuming that the more differentiated species holds a higher position in the sequence, I placed the zone of *Parallelipipedum prototortuosum* below that of *Arca theobaldi*. The following is a list of species described from this bed :—

1. *Paracyathus caeruleus*, Duncan.
2. *Cidaris spec. 1.*
3. " *spec. 2.*
4. *Ostrea papyracea*, spec. nov.
5. *Pecten kokenianus*, spec. nov.
6. *Arca theobaldi*, spec. nov.
7. " *metabistrigata*, spec. nov.
8. " *myoënsis*, spec. nov.
9. " *nannodes*, K. Martin.
10. " *bataviana*, K. Martin.

11. *Nucula alcocki*, Noetling.
12. *Leda virgo*, K. Martin.
13. *Dione protolilacina*, spec. nov.
14. „ *amygdaloides*, spec. nov.
15. „ *protophilippinarum*, spec. nov.
16. *Tellina grimesi*, spec. nov.
17. „ *protostriatula*, spec. nov.
18. „ *foliacea*, Reeve.
19. „ *killi*, Noetling.
20. *Gari protokingi*, spec. nov.
21. *Corbula socialis*, K. Martin.
22. „ *prototruncata*, spec. nov.
23. *Dentalium bœttgeri*, spec. nov.
24. *Calliostoma kœnenianum*, spec. nov.
25. *Basilissa loriolana*, spec. nov.
26. *Turcica protomonilifera*, spec. nov.
27. *Solarium maximum*, Philippi.
28. *Torinia protodorsuosa*, spec. nov.
29. *Turritella simplex*, Jenkins.
30. „ *acuticarinata*, Dunker.
31. *Calyptraea rugosa*, Noetling.
32. *Natica callosa*, Sowerby.
33. „ *obscura*, Sowerby.
34. „ *spec.*
35. *Fossarus krausei*, spec. nov.
36. *Rimella scripta*, Sowerby spec.
37. *Galeodea monilifera*, spec. nov.
38. *Triton pardalis*, Noetling.
39. „ *neocolubrinus*, spec. nov.
40. *Persona gautama*, spec. nov.
41. *Ranella prototubercularis*, spec. nov.
42. *Eburna protozeylanica*, spec. nov.
43. *Marginella scripta*, Reeve.
44. *Oliva rufula*, Duclos.
45. *Cancellaria neavolutella*, spec. nov.
46. „ *inornata*, spec. nov.
47. *Strioterebrum protomyuros*, spec. nov
48. „ *unicinctum*, spec. nov.
49. „ *bicinctum*, K. Martin.
50. *Terebrum protoduplicatum*, spec. nov.
51. *Pleurotoma karenaica*, spec. nov.
52. *Surcula feddeni*, Noetling.
53. *Drillia protointerrupta*, spec. nov.
54. „ *promensis*, spec. nov.
55. „ *protocincta*, spec. nov.
56. *Conus avaënsis*, spec. nov.
57. *Balanus tintinnabulum*, Linné.
58. *Callianassa birmanica*, spec. nov.

8. *Thayetmyo* sandstone.—The zone of *Arca theobaldi* closes the fossiliferous series in lower Burma; at least according to Mr. Theobald no more fossiliferous

beds occur above the Kama clay, except at the end of the series.[1] Mr. Theobald only states that this series is composed of sandstones and shales, but gives no particulars as to colour or thickness. I presume that yellow tinges prevail, because to judge from Mr. Theobald's section on page 84 it is unquestionable that yellow colours preponderate in his B group, and because in upper Burma this colour generally supersedes the grey tinge of the lower beds. As regards the thickness, it is difficult to form an opinion of what Mr. Theobald means by a "very thick series," but I suppose that, if we estimate the thickness to be about 1,000 feet, it will be rather below than above the mark. As already stated, I believe that the zones of *Ostrea promensis*, and *Ostrea peguensis*, if both really occur in different horizons and not together in one bed, are found in this series.

9. Zone of *Turritella acuticarinata*, Dunker.—Mr. Theobald's collection does not contain any specimens from this bed, and it is only on the strength of his remark of "the occurrence of a species of *Turritella* hardly distinguishable from one now living on the coast" which can be only this, or *Turritella simplex*, Jenkins, which could come into consideration, for both are certainly very close relatives of the living *Turritella duplicata*, that I call this zone by the name of this species.

This zone closes the *Pegu* division, and immediately above it follows the *Irrawaddi* series (Fossil wood group, Theobald). The section in lower Burma would, therefore, be in descending order as follows :—

Pliocene.	Irrawaddi Series (Fossil wood group).			Thickness unknown.
Upper Miocene .	Pegu Division.	Yenangyoungian.	9. Zone of *Turritella acuticarinata*, Dunker . .	10 feet.
			8. *Thayetmyo*-sandstone . . . . . 8*b* Zone of *Ostrea peguensis*, spec. nov. 8*a* Zone of *Ostrea promensis*, spec. nov.	1,000 "
			7. Zone of *Arca theobaldi*, spec. nov. . . 6. Zone of *Parallelipipedum prototortuosum*, spec. sevenov.	20 "
			5. Sandstones and shales not seen	500 "
			4. A series of sandstones and shales containing ral fossiliferous horizons, probably 4*b* Zone of *Pholas orientalis*, Gmel. . . 4*a* Zone of *Aricia humerosa*, Sow. spec.	514 "
			3. Zone of *Cytherea erycina*, Fav.	5 "
Lower Miocene		Promeian.	2. *Prome*-sandstone	1,418 "
			1. *Sitsyahn*-shales	800 "

[1] I may mention here that the strata from which Mr. Theobald obtained a *Pseudodiadema* and other Echinoids are perhaps of Eocene age, unless they represent the supposed coralline facies. The so-called *Ngathaung*-beds are most probably of alluvial age.

(*B*)—*Upper Burma.*

(*a*) Minbu.

Though of course Tertiary beds are exposed everywhere north of Thayetmyo between this place and Minbu, no examination has been carried out in this part of the country. The southernmost locality where Tertiary beds have been studied, is the small village of Minbu, Lat. 20° 10′ N., Long. 94° 56′ E., on the right bank of the Irrawaddi, 423 miles north of Rangoon.[1]

Any section near Minbu taken from the river bank in western direction proves that the strata form an unsymmetrical anticlinal arch, the sides of which are formed by the *Irrawaddi* series, while in the centre the *Pegu* division is exposed. Near the river the beds dip vertically and are even reversed at some places; this vertical dip continues for a distance of about 1,000 feet from the river bank, but then the angle lessens, and within a distance of 600 feet in horizontal direction from the last vertically dipping bed, the strata dip at an angle of 15° towards east; the angle becomes smaller and smaller till it becomes perfectly horizontal in the low ridge forming the northern end of the valley in which the mud volcanoes are situated. The dip assumes now rather quickly a western direction, and an angle of 12° to 15° is observed, which apparently remains unchanged as far as I have followed the strata in western direction.

The strata exposed in this anticlinal consist of layers of hard sandstone near the river bank, separated by beds of brown clay; the hard banks disappear and are gradually replaced by olive-coloured clays, containing gypsum, and an occasional thin layer of flaggy, hard sandstone. In the centre of the anticlinal the clay assumes a more bluish colour, the intercalated beds of sandstone being of brown colour; this last named series is exposed for about 150 feet in thickness and contains the fauna mentioned below. There are apparently several fossiliferous beds, but the fauna here described comes from a bed of light coloured, calcareous sandstone close to the surface which I termed the zone of ***Cancellaria martiniana.*** The following fossils have been described from this bed :—

1. *Paracyathus caeruleus*, Duncan.
2. *Pecten irravadicus*, spec. nov.
3. *Pinna spec.*
4. *Arca bistrigata*, Dunker.
5. *Nucula alcocki*, Noetling.
6. *Dione dubiosa*, Noetling.
7. „ *protophilippinarum*, spec. nov.
8. *Tellina hilli*, Noetling.
9. *Gari kingi*, Noetling.
10. *Corbula prototruncata*, spec. nov.
11. *Calliostoma blanfordi*, Noetling.
12. *Solarium maximum*, Philippi.

[1] Distance by river.

13. *Torinia protodortuosa*, spec. nov.
14. „ *buddha*, Noetling.
15. *Discohelix minuta*, Noetling.
16. *Scalaria spathica*, spec. nov.
17. „ *birmanica*, Noetling.
18. „ *irregularis*, Noetling.
19. *Turritella affiniformis*, spec. nov.
20. *Calyptraea rugosa*, Noetling.
21. *Natica callosa*, Sowerby.
22. „ *obscura*, Sowerby.
23. *Cypraea granti* ,d'Archiac and Haime
24. *Cassis d'archiaci*, Noetling.
25. *Semicassis protojaponica*, spec. nov.
26. *Oniscidia minbuensis*, Noetling.
27. *Ficula theobaldi*, Noetling.
28. *Triton pardalis*, Noetling.
29. *Ranella prototubercularis*, spec. nov.
30. *Fusus seminudus*, spec. nov.
31. *Fasciolaria nodulosa*, Sowerby.
32. *Murex arrakanensis*, Noetling.
33. *Volvaria birmanica*, Noetling.
34. *Voluta ringens*, spec. nov.
35. „ *dentata*, Sowerby.
36. *Oliva rufula*, Duclos.
37. *Cancellaria davidsoni*, d'Archiac and Haime.
38. „ *martiniana*, spec. nov.
39. *Terebrum smithi*, K. Martin.
40. *Subula spec.*
41. *Surcula feddeni*, Noetling.
42. *Genota irravadica*, Noetling.
43. *Clavatula protonodifera*, spec. nov.
44. *Drillia protointerrupta*, spec. nov.
45. *Conus malaccanus*, Hwas.
46. *Balanus tintinnabulum*, Linné.
47. *Callianassa birmanica*, spec. nov.
48. *Cancer spec.*
49. *Myliobates spec.*
50. *Carcharias gangeticus*, Müller and Henle.
51. *Galeocerdo spec.*
52. *Lamna spallanzanii*, Bonaparte.

The delimitation of the beds composing this section is not very easy; it seems unquestionable that no strata belonging to the ***Promeian*** have come to the surface, though the existence of this group in greater depth is apparently proved by the mud, ejected from the mud volcanoes, the appearance of which is exactly alike that from the drilled bore holes of Yenangyoung.

The occurrence of fragments of fossil bones, among which ***Trionyx*** spec. was recognized in some of the conglomeratic beds near the river bank, proves that the

strata here exposed belong to the *Irrawaddi* series, though there is undoubtedly a gradual passage to the upper beds of the *Yenangyoungian*.

The section exposed near Minbu could therefore in descending order be interpreted as follows:—

Pliocene.	Irrawaddi Series.			Thickness not measured.
Upper Miocene.	Pegu Division.	*Yenangyoungian.*	5. *Minbu* shales, olive-coloured unfossiliferous clay with layers of hard concretionary sandstone . .	1,300 feet.
			4. Bluish clay, unfossiliferous	150 "
			3. Zone of *Cancellaria martiniana*, spec. nov. .	5 "
			2. Bluish clay with layers of fossiliferous sandstone .	150 "
Lower Miocene.		*Promeian.*	1. Petroliferous sandstone, and clays not exposed .	Thickness unknown.

(*b*) YENANGYOUNG.

The important village of Yenangyoung, Lat. 20° 29′ N. and Long. 94° 56′ E., is situated on the left bank of the Irrawaddi, 458 miles north of Rangoon.[1] The strata form a very flat, symmetrical anticlinal arch, the top of which has been greatly planed down by subsequent denudation. As almost all the chief valleys cut the anticlinal arch at right angles, very good sections can be seen, but it is only for the comparatively small horizontal distance of 5,100 feet, measured along the line of greatest exposure, that beds older than the *Irrawaddi* series are exposed in the centre of the anticline.

Marching from the river in eastern direction, strata belonging to the *Irrawaddi* series will be observed dipping at 37° to 38° in south-western direction; the lower boundary of the *Irrawaddi* series being well defined, their carefully measured thickness was found to be 4,620 feet.

Below the basal bed of the *Irrawaddi* series, the zone of *Hippotherium antelopinum* and *Acerotherium perimense*, follows a series of soft olive-coloured clays alternating with thin beds of sandstone, measuring 1,100 feet in thickness. In the top layer of this series, immediately underneath the basal conglomerate, I discovered on the eastern side of the anticlinal arch, near Milindoung, two patches full of shells of *Cyrena* (*Batissa*) *crawfurdi*, and *Cyrena* (*Batissa*) *petrolei*, but nowhere else these species have so far been found again. I therefore termed the top layer of the *Yenangyoungian* zone of *Cyrena* (*Batissa*) *crawfurdi*, though it must be understood that it is unfossiliferous for its greatest part. The following fossils have been described from this bed:—

1. *Cyrena* (*Batissa*) *crawfurdi*, Noetling.
2. " " *petrolei*, Noetling.
3. " " *kodoungensis*, spec. nov.

Except this local occurrence of *Cyrena* the *Yenangyoungian* is absolutely

[1] Distance by river.

unfossiliferous and even the most careful examination failed to discover any fossils; on the other hand, the strata are characterised by an abundance of gypsum.

In the very centre of the anticline, and exposed for 1,320 feet in horizontal distance, the top beds of the *Promeian*, characterised by bluish-grey sandstones and blue clays rise to the surface. The sequence of the *Promeian* has, however, been demonstrated by the native pit wells, as well as by the sections recorded in the drilled wells. It is composed of a series of bluish-grey sandstones, often charged with either water or petroleum, separated by clunchy clays of bluish colour.

The thickness of the *Promeian* is not fully known yet; in the centre of the anticlinal arch where the beds are almost flat the drill went through upwards of 1,100 feet without reaching the base.

The *Promeian* is almost unfossiliferous; only in its upper part, about 150 feet from the top, a fossiliferous layer of small extension, containing a curiously mixed fauna of truly marine species and terrestrial animals has been found. The following species have been described from this bed which I styled zone of *Anoplotherium birmanicum*, spec. nov. :—

1. *Paracyathus caeruleus*, Duncan.
2. *Pecten kokenianus*, spec. nov.
3. *Lithodomus*, spec.
4. *Arca bistrigata*, Dunker.
5. *Dione protophilippinarum*, spec. nov.
6. *Cardium cf. minbuense*, Noetling.
7. *Myliobates*, spec.
8. *Carcharias gangeticus*, Müller and Henle.
9. *Siluroid gen.*
10. *Python cf. molurus*, Linné.
11. *Crocodilus palustris*, Less.
12. *Gharialis gangeticus*, Gmelin.
13. *Anoplotherium birmanicum*, spec. nov.

The section of the Yenangyoung anticlinal would be, therefore, as follows, in descending order :—

<table>
<tr><td>Pliocene.</td><td colspan="3">Irrawaddi Series.</td><td>4,620 feet.</td></tr>
<tr><td rowspan="2">Upper Miocene.</td><td rowspan="8">Pegu Division.</td><td rowspan="2">Yenangyoungian.</td><td>8. Zone of Cyrena (Batissa) crawfurdi . . .</td><td>20 feet.</td></tr>
<tr><td>7. Unfossiliferous, olive-coloured clays containing gypsum . . . .</td><td>1,060 „</td></tr>
<tr><td rowspan="6">Lower Miocene.</td><td rowspan="6">Promeian.</td><td>6. Unfossiliferous bluish clays and sandstones, 1st oil sand. . . . . .</td><td>150 feet.</td></tr>
<tr><td>5. Zone of Anoplotherium birmanicum, spec. nov. .</td><td>0 „ 4"</td></tr>
<tr><td>4. Unfossiliferous bluish clays and sandstones, 2nd oil sand . . . .</td><td>50 „</td></tr>
<tr><td>3. Bluish clay . . . .</td><td>20 „</td></tr>
<tr><td>2. Unfossiliferous sand, 4th oil sand . . .</td><td>30 „</td></tr>
<tr><td>1. A series of alternating sandstones and clays . .</td><td>850 „</td></tr>
</table>

(c) SINGU.

The little village of Singu, 518 miles north of Rangoon,[1] is situated on the left bank of the Irrawaddi, Lat. 21° 5′ N. and Long. 94° 51′ E., near the eastern end of the cross channel which the Irrawaddi has dug through the *Pegu* and *Irrawaddi* series, exposing one of the finest sections through the Upper Tertiary formation that can be seen in Burma.

The strata form an unsymmetrical anticlinal arch the eastern side of which is the shorter; in the centre the *Yenangyoungian* is exposed, and the western side is mostly composed of the *Irrawaddi* series extending in western direction as far as Silemyo, and exhibiting a thickness of not less than 20,000 feet. The late Mr. Grimes has measured a good section about three miles south of Singu, and I shall combine here his with my own observations.

Marching from Singu in western direction the beds of the *Irrawaddi* series will first be met with, along the bank of a little stream, dipping at a very high angle, almost 90° in eastern direction; the dip lessens, and gradually conglomeratic beds, containing fragments of fossil bones, are met with, which indicate the base of the *Irrawaddi* series.

Immediately below, and apparently perfectly conformable, follows the *Yenangyoungian*, characterised by a series of olive-coloured clays containing strings of harder sandstone. According to the late Mr. Grimes, these beds, for which the name *Singu* shales would be appropriate, are unfossiliferous up to a thickness of 1,450 feet from the top. The highest fossiliferous bed met with is a band of calcareous sandstone of brown colour, containing a few ill-preserved specimens of *Cardita tjidamarensis*, K. Martin.

Below this bed follow some more unfossiliferous strata of greenish colour measuring about 100 feet in thickness, after which one of the most important beds is found. This is a very hard glauconitic sandstone of bluish-green, or dark-green colour, containing a rich fauna; the shells are generally well preserved and shine out beautifully in their white lustre from the surrounding bluish-green matrix. From the frequency of *Mytilus nicobaricus*, Reeve, I have called it the zone of *Mytilus nicobaricus*, and the species described from this horizon are given in the following list:—

1. *Paracyathus caeruleus*, Duncan.
2. *Lima protosquamosa*, spec. nov.
3. *Pecten irravadicus*, spec. nov.
4. *Vulsella lingua-tigris*, spec. nov.
5. *Mytilus nicobaricus*, Reeve.
6. *Modiola buddhaica*, spec nov.
7. „ *pseudobuddhaica*, spec. nov.
8. *Arca bistrigata*, Dunker.
9. *Cardita viquesneli*, d'Archiac and Haime.
10. „ *planicosta*, spec. nov.
11. „ *cf. mutabilis*, d'Archiac and Haime.

[1] Distance by river.

12. *Crassatella dieneri*, spec. nov.
13. *Cardium minbuense*, spec. nov.
14. *Meiocardia metavulgaris*, spec. nov.
15. *Dione protolilacina*, spec. nov.
16. „ *amygdaloides*, spec. nov.
17. „ *protophilippinarum*, spec. nov.
18. *Tellina grimesi*, spec. nov.
19. *Gari deuterokingi*, spec. nov.
20. *Corbula rugosa*, Sowerby.
21. *Dentalium junghuhni*, K. Martin.
22. *Calliostoma blanfordi*, Noetling.
23. *Basilissa lorioliana*, spec. nov.
24. *Solarium maximum*, Philippi.
25. *Turritella simplex*, Jenkins.
26. *Siliquaria spec.* ?
27. *Calyptraea rugosa*, Noetling.
28. *Natica obscura*, Sowerby.
29. *Sigaretus neritoideus*, Linné.
30. *Cypraea granti*, d'Archiac and Haime.
31. *Galeodea monilifera*, spec. nov.
32. *Ficula theobaldi*, Noetling.
33. *Pyrula bucephala*, Lamarck.
34. „ *pseudobucephala*, spec. nov.
35. *Oliva rufula*, Duclos.
36. *Genota irravadica*, Noetling.
37. *Clavatula fulminata*, Kiener, spec.
38. „ *protonodifera*, spec. nov.
39. *Conus avaënsis*, spec. nov.
40. *Callianassa birmanica*, spec. nov.
41. *Lamna spallanzanii*, Bonaparte.
42. *Carcharias gangeticus*, Müller and Henle.

Then follows a series of unfossiliferous beds of olive-green colour probably measuring about 300 feet, and then another fossiliferous layer, which I termed the zone of *Meiocardia metavulgaris*, spec. nov.,[1] is met with.

This zone is represented by a soft, argillaceous sandstone of brown colour containing, however, numbers of grains of glauconite. The lithological appearance leads to the belief that volcanic ash has greatly contributed towards its composition. Other remarkable features are numerous lumps of hardened clay, which prove unquestionably that previous to their imbedding they were perfectly riddled by the holes of *Lithodomus* spec. which have now become filled up with the surrounding matrix.

Fossils are numerous, but there is no great variety, and the preservation is not always the best, particularly that of the Gastropoda, the shell of which

[1] This bed is identical with the *Cypricardia* bed of my former paper (Dev. and Sub. of Ter., page 74). At that time the true generic position of *Meiocardia metavulgaris* was not known to me, and misled by its shape I believed it to be a *Cypricardia*.

has been in most cases destroyed. The following is the list of fossils described from this bed :—

1. *Paracyathus caeruleus*, Duncan.
2. *Pecten irravadicus*, spec. nov.
3. *Avicula suessiana*, spec. nov.
4. *Vulsella lingua-tigris*, spec. nov.
5. *Modiola buddhaica*, spec. nov.
6. *Lithodomus spec.*
7. *Arca bistrigata*, Dunker.
8. *Nucula alcocki*, Noetling.
9. *Leda birmanica*, spec. nov.
10. *Cardita scabrosa*, spec. nov.
11. „ *tjidamarensis*, K. Martin.
12. „ *viquesneli*, d'Archiac and Haime.
13. „ *cf. mutabilis*, d'Archiac and Haime.
14. *Crassatella dieneri*, spec. nov.
15. *Meiocardia metavulgaris*, spec. nov.
16. *Dione protolilacina*, spec. nov.
17. „ *protophilippinarum*, spec. nov.
18. *Tellina grimesi*, spec. nov.
19. *Gari kingi*, Noetling.
20. *Corbula rugosa*, Sowerby.
21. *Calliostoma blanfordi*, Noetling.
22. *Turcica protomonilifera*, spec. nov.
23. *Basilissa lorioliana*, spec. nov.
24. *Solarium maximum*, Philippi.
25. *Cypraea granti*, d'Archiac and Haime.
26. *Galeodea monilifera*, spec. nov.
27. *Ficula theobaldi*, Noetling.
28. *Conus avaënsis*, spec. nov.
29. *Balanus tintinnabulum*, Linné.
30. *Callianassa birmanica*, spec. nov.
31. *Lamna spallanzanii*, Bonaparte.
32. *Carcharias gangeticus*, Müller and Henle.

Then follows another 300 feet of unfossiliferous beds below which there are several thin beds of hard sandstone the surface of which is covered with numerous fossils; most of them are, however, in a very fragmentary state of preservation and only a few specimens could be determined specifically. The following is the list of fossils described from this bed which I called zone of *Dione dubiosa* :—

1. *Lucina d'archiaciana*, spec. nov.
2. *Dione dubiosa*, Noetling.
3. *Corbula prototruncata*, spec. nov.
4. *Scalaria leptopleurata*, spec. nov.

Then follows another series of unfossiliferous beds, measuring about 300 feet, below which must come the *Promeian*, though this division is apparently

nowhere exposed on the surface. The section near Singu is therefore in descending order :—

Pliocene.	Irrawaddi Series.			20,000 feet.
Upper Miocene .	Pegu Division.	*Yenangyoungian.*	10. *Singu* shales, unfossiliferous	1,450 feet.
			9. Zone of *Cardita tjidamarensis*, K. Martin .	0 " 6"
			8. Unfossiliferous sandstone and clay . . .	100 "
			7. Zone of *Mytilus nicobaricus*, Chemn. . .	0 " 6"
			6. Unfossiliferous sandstone and clay . . .	300 "
			5. Zone of *Meiocardia metavulgaris*, spec. nov. .	1 "
			4. Unfossiliferous sandstone and clay . . .	300 "
			3. Zone of *Dione dubiosa*, Noetling . . .	0 " 6"
			2. Unfossiliferous sandstone and clay . . .	300 "
Lower Miocene .		*Promeian.*	1. Petroliferous sandstone and clay not exposed .	Thickness unknown.

(*d*) YENANGYAT.

The little village of Yenangat, Lat. 21° 6′ N., Long. 94° 51′ E., is situated on the right bank of the Irrawaddi, about 540 miles from Rangoon,[1] at the eastern foot of the Tangyi hill range. This range is formed by an unsymmetrical anticlinal arch, dipping almost vertically on its eastern, and very gently on its western side. Wherever the valleys have cut in deeply enough, the *Yenangyoungian* can be seen in the centre, while the sides are formed by the *Irrawaddi* series.

Marching from the river bank along the Yenanchoung ravine, in western direction for about 500 or 600 feet, the *Irrawaddi* series can be seen dipping at about 70° to 80° in eastern direction. The dip slowly decreases to about 45° at a distance of 1,200 feet from the river, and then suddenly changes to 7° west.

Below the *Irrawaddi* series follows a series of olive-coloured clays with interstratified beds of sandstone sometimes very hard, sometimes rather soft. The thickness of these series seems to vary greatly owing to the extensive denudation which it underwent, previous to the deposit of the *Irrawaddi* series. In the Yenanchoung ravine I observed a thickness of about 500 feet, but the late Mr. Grimes thinks that at some localities in the Tangyi range it is rather more. The correctness of this view can only be proved by future researches.

Fossils are scarce and scattered, generally ill preserved, but apparently of marine character. A few have been found about 350 feet above the base of the *Yenangyoungian* in a hard, thinly bedded sandstone, the surface of which is covered with a perfect agglomerate of shell fragments, but containing only a few

[1] Distance by river.

well preserved specimens. From the frequency of the occurrence of *Dione dubiosa* this horizon has been termed zone of *Dione dubiosa*, and the following species have been recognised :—

1. *Lucina d'archiaciana*, spec. nov.
2. *Dione dubiosa*, Noetling.
3. *Corbula prototruncata*, spec. nov.
4. *Scalaria leptopleurata*, spec. nov.

The Yenangyoungian gradually passes into the bluish coloured beds, and the zone of *Paracyathus caeruleus*, as I called it from the frequent occurrence of this species, apparently concludes this series, from which the following species have been described :—

1. *Paracyathus caeruleus*, Duncan.
2. *Eupsammia regalis*, Alcock.
3. *Pecten irravadicus*, spec. nov.
4. *Arca bistrigata*, Dunker.
5. *Nucula alcocki*, Noetling.
6. *Lucina pagana*, spec. nov.
7. *Dione amygdaloides*, spec. nov.
8. „ *protophilippinarum*, spec. nov.
9. *Tellina hilli*, Noetling.
10. *Gari kingi*, Noetling.
11. *Solen spec.*
12. *Calliostoma blanfordi*, Noetling.
13. *Solarium maximum*, Philippi.
14. *Torinia buddha*, Noetling.
15. *Turritella affiniformis*, spec. nov.
16. *Siliquaria, spec.* 1.
17. *Calyptraea rugosa*, Noetling.
18. *Natica callosa*, Sowerby.
19. „ *obscura*, Sowerby.
20. *Sigaretus neritoideus*, Linné.
21. *Cypraea granti*, d'Archiac and Haime.
22. *Trivia smithi*, K. Martin.
23. *Ficula theobaldi*, Noetling.
24. *Triton pardalis*, Noetling.
25. „ *neastriatulus*, spec. nov.
26. *Ranella prototubercularis*, spec. nov.
27. *Fusus seminudus*, spec. nov.
28. *Fasciolaria nodulosa*, Sowerby.
29. *Murex* (?) *tchihatcheffi*, d'Archiac and Haime
30. *Voluta dentata*, Sowerby.
31. *Oliva rufula*, Duclos
32. *Cancellaria pseudocancellata*, spec. nov.
33. „ *davidsoni*, d'Archiac and Haime.
34. „ *martiniana*, spec. nov.
35. *Terebrum spec.*
36. *Surcula feddeni*, Noetling.
37. *Drillia yenanensis*, Noetling.

38. *Conus malaccanus*, Hwas.
39. „ *protofurvus*, spec. nov.
40. „ *galensis*, spec. nov.
41. *Balanus tintinnabulum*, Linné.
42. *Callianassa birmanica*, spec. nov.
43. *Myliobates*, *spec.*
44. *Lamna spallanzanii*, Bonaparte.
45. *Carcharias gangeticus*, Müller and Henle.
46. *Otolithus*, *spec.*

Below this follows the monotonous series of the *Promeian* composed of bluish sandstones and clays, the former charged with petroleum, is known to upwards of 1,000 feet without reaching the base. The following would therefore represent the section in the Yenanchoung ravine, though it must be understood that it probably does not exhibit the full thickness of the *Yenangyoungian*. In descending order the sequence is as follows:—

Pliocene.	Irrawaddi Series.			Thickness not known.
Upper Miocene .	Pegu Division.	*Yenangyoungian.*	5. Unfossiliferous clays of olive coloured sandstones alternating with clays	150 feet.
			4. Zone of *Dione dubiosa*, Noetling	10 „
			3. Unfossiliferous clays with hard concretions and beds of sandstones	350 „
			2. Zone of *Paracyathus caeruleus*, Duncan . .	10 „
Lower Miocene .		*Promeian.*	1. A series of unfossiliferous sandstones frequently petroliferous, alternating with beds of clay.	Upwards of 1,000 feet.

(*e*) Chindwin District.

I visited the Chindwin District as far back as 1889, and since that time no further survey has been made of this remote and very jungly district. I obtained, however, two fairly good sections along the Nantahin ravine and the bed of the Yu river, though my visit at the time was a rather hurried one and I was not able to spend much time in searching for fossils. Whether the *Yenangyoungian* is therefore really destitute of fossils, as it appeared to be, or whether future researches will reveal the existence of fossiliferous beds, remains to be seen. The section in descending order is as follows :—

Pliocene.	Irrawaddi Series.		20,000 feet.
Upper Miocene.	Pegu Division.	*Yenangyoungian.*	3,000 feet.
Lower Miocene.		*Promeian.*	3,800 feet.

The occurrence of the *Yenangyoungian* is not without any doubt, as the lithological characters of this series are rather those of the *Promeian*, *viz.*, pepper and

salt coloured sandstone, alternating with beds of bluish clay. The probability that the *Yenangyoungian* has not been deposited at all in this part of the country, is by no means small. If this view be true, and the whole series of strata were to represent the *Promeian*, an unconformity would exist between *Promeian* and *Yenangyoungian*. This view is to some extent corroborated by observations in the Yenangyoung oil-field,[1] where a local overlap of the *Yenangyoungian* has been observed. It requires, however, a good deal of further researches before this question can be finally decided.

(*f*) Correlation of the different sections.

On the following table I tried to correlate the first five sections, omitting that of the Chindwin for not giving a sufficient amount of detail. Each section is drawn to scale of thickness, in order to show the position the fossiliferous horizons hold in the sequence.

In explanation of this table, a few words must be said, otherwise an erroneous idea might be conceived. The table does not show the absolute correlation of the different fossiliferous horizons, and does not pretend to do so. Each section, as already said, has been drawn to scale, that is to say, the fossiliferous horizons are represented in their correct height above the base of the *Yenangyoungian*, except those of *Aricia humerosa* and *Pholas orientalis*, the position of which in the sequence is not known (see above, page 19), and their place is therefore a purely hypothetical one. The still more doubtful horizons of *Ostrea peguensis*, and *Ostrea promensis* have been entirely omitted, though, if my supposition is correct, they ought to be shown in the *Thayetmyo*-sandstone. The sections have been placed next to each other, assuming at the same time that the boundary between the *Promeian* and *Yenangyoungian* represents a constant level. If this view is correct, the sections would prove better than a description could do that the boundary between the *Yenangyoungian* and the *Irrawaddi* series is a very irregular one; in other words, that there exists an unconformity between the *Pegu* division (Miocene) and the *Irrawaddi* series (Pliocene). At places the denudation of the *Yenangyoungian* caused a considerable portion of its upper part to disappear, and though, for instance, the zone of *Cyrena crawfurdi* represents at present the top of the *Yenangyoungian*, near Yenangyoung, it was originally much further down in the series, and its high position is only an apparent one. I have dwelt on this fact on page 10, and if my assumption be right, the view of the unconformity between the two main divisions of the Tertiary of Burma would be strongly supported by the sections. On the other hand, the regularity of the boundary line between *Promeian* and *Yenangyoungian* is by no means an established fact, and I spoke above of the probability of an unconformity between the two parts of the *Pegu* division. If such an unconformity exists and would not be local only, then the sections had of course to be arranged differently and the boundary between the *Yenangyoungian* and *Irrawaddi* series would not be such an extremely irregular one as demonstrated by the sections.

I wish, however, to say that so far the evidence of observations is more in favour of an unconformity between the *Arrakan* and *Irrawaddi* series than within

[1] The occurrence of Petroleum in Burma, page 77 *ff*.

the former itself, between *Yenangyoungian* and *Promeian*, though local overlaps unquestionably occur.

		THAYETMYO, PROME.	MINBU.	YENANGYOUNG.	SINGU.	YENANGYAT.
	PLIOCENE.	Irrawaddi Series.	Irrawaddi Series.	Irrawaddi Series.	Irrawaddi Series. Singu shales.	Irrawaddi Series.
MIOCENE	YENANGYOUNGIAN.	Zone of *Turritella acuticarinata*. Thayetmyo sandstone. Zone of *Arca theobaldi*. Zone of *Parallelipip. prototortuosum*.	Minbu shales.	Zone of *Cyrena crawfurdi*.	Zone of *Cardita tjidamarensis*. Zone of *Mytilus nicobaricus*.	
		Zone of *Pholas orientalis*. Zone of *Aricia humerosa*. Zone of *Cytherea erycina*.	Zone of *Cancellaria martiniana*.	Twingon shales.	Zone of *Meiocardia metavulgaris*. Zone of *Dione dubiosa*.	Zone of *Dione dubiosa*. Zone of *Paracyathus caeruleus*.
	PROMEIAN.	Prome sandstone. (Petroliferous sandstone near Padaukbin and Carboniferous beds near Thayetmyo.)	Petroliferous sandstone.	Zone of *Anoplotherium birmanicum*. Petroliferous sandstone.	Petroliferous sandstone.	Petroliferous sandstone.
		Sitsyahn shales.				

2.—Vertical Distribution of the Fossils.

(*A*) *General Remarks.*

The following table gives the vertical distribution of the fossils: for convenience sake, the five horizons of lower Burma have been put together, while the remaining eight represent those of upper Burma. In the last column those fossils are enumerated, the geological horizon of which is not known, but of which it is certain that they do not occur in any of the named horizons. The sequence of the columns therefore does not quite represent the way they are actually following in ascending order, because without knowing more about the correlation of the fossiliferous horizons of lower and upper Burma, I think it better not to mix them. In the lower Burma horizons the sequence has been given as it is assumed to be, while the upper Burma horizons represent the natural sequence:—

Name of species.	Zone of *Cytherea erycina.*	Zone of *Aricia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parallelipipedum prototortuosum*	Zone of *Arca theobaldi.*	Zone of *Anoplotherium birmanicum.*	Zone of *Paracyathus caeruleus.*	Zone of *Cancellaria martiniana.*	Zone of *Dione dubiosa.*	Zone of *Meiocardia metavulgaris.*	Zone of *Mytilus nicobaricus.*	Zone of *Cardita tjidamarensis.*	Zone of *Cyrena crawfurdi.*	Uncertain.
ANTHOZOA.														
1 *Ceratotrochus alcockianus*, spec. nov.	•	.	.	•	.	.	.	.	.	.	.	.	.	.
2 *Flabellum distinctum*, Milne Edwards	•	•	•	•	.	.	.	.	.	.	.	.	.	•
3 *Paracyathus caeruleus*, Duncan.	.	.	.	•	•	•	•	•	.	•	•	.	.	.
4 *Eupsammia regalis*, Alcock.	.	.	.	.	.	.	•	.	.	.	.	.	.	.
ECHINOIDEA.														
5 *Cidaris*, spec. 1	.	.	.	•	•	.	.	.	.	.	.	.	.	.
6 „ spec. 2	.	.	.	.	•	.	.	.	.	.	.	.	.	.
7 *Clypeaster duncanianus*, spec. nov.	.	.	.	.	.	.	.	.	.	.	.	.	.	•
PELECYPODA.														
8 *Ostrea peguensis*, spec. nov.	.	.	.	.	.	.	.	.	.	.	.	.	.	•
9 „ *promensis*, spec. nov.	.	.	.	.	.	.	.	.	.	.	.	.	.	•
10 „ *promensis*, spec. nov. var.	.	.	.	.	.	.	.	.	.	.	.	.	.	•
11 „ *papyracea*, spec. nov.	.	.	.	•	•	.	.	.	.	.	.	.	.	.
12 *Spondylus*, spec.	.	•	.	.	.	.	.	.	.	.	.	.	.	.
13 *Lima griesbachiana*, spec. nov.	.	•	.	.	.	.	.	.	.	.	.	.	.	.
14 „ *protosquamosa*, spec. nov.	.	.	.	.	.	.	.	.	.	.	•	.	.	.

NAME OF SPECIES.	Zone of *Cytherea erycina.*	Zone of *Aricia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parallelipipedum prototortuosum*	Zone of *Arca theobaldi*	Zone of *Anoplotherium birmanicum.*	Zone of *Paracyathus caeruleus.*	Zone of *Cancellaria martiniana.*	Zone of *Dione dubiosa.*	Zone of *Meiocardia metavulgaris.*	Zone of *Mytilus nicobaricus.*	Zone of *Cardita tjidamarensis.*	Zone of *Cyrena crawfurdi.*	Uncertain.
15 *Pecten protosenatorius*, spec. nov.														•
16 " *kokenianus*, spec. nov.	•	•	•	•	•	•								
17 " *irravadicus*, spec. nov.							•	•		•	•			
18 *Avicula suessiana*, spec. nov.										•				
19 *Vulsella lingua-tigris*, spec. nov.				•						•	•			
20 *Mytilus nicobaricus*, Reeve.											•			
21 *Modiola buddhaica*, spec. nov.										•	•			
22 " *pseudobuddhaica*, spec. nov.											•			
23 *Lithodomus*, spec.						•				•				
24 *Pinna*, spec.			•					•						
25 *Arca burnesi*, d'Archiac and Haime.				•										
26 " *theobaldi*, spec. nov.					•									
27 " *thayetensis*, spec. nov.														•
28 " *punctabistrigata*, spec. nov.					•									
29 " *bistrigata*, Dunker.						•	•	•		•	•			
30 " *oldhamiana*, spec. nov.			•											
31 " *yawensis*, spec. nov.				•										
32 " *myoënsis*, spec. nov.	•				•									
33 " *nannodes*, K. Martin.		•			•									
34 " *bataviana*, K. Martin.			•		•									
35 " *peethensis*, d'Archiac and Haime.			•	•										
36 *Parallelipipedum prototortuosum*, spec. nov.				•										
37 *Cucullaea protoconcamerata*, spec. nov.														•
38 *Nucula alcocki*, Noetling.					•		•	•		•				
39 " *phayreiana*, spec. nov.				•										
40 *Leda birmanica*, spec. nov.										•				
41 " *virgo*, K. Martin.					•									
42 " *avaënsis*, spec. nov.				•										
43 *Cardita scabrosa*, spec. nov.										•				

Name of species.	Zone of *Cytherea erycina.*	Zone of *Arcia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parallelipipedum prototortuosum*	Zone of *Arca theobaldi.*	Zone of *Anoplotherium birmanicum.*	Zone of *Paracyathus caeruleus.*	Zone of *Cancellaria martiniana.*	Zone of *Dione dubiosa.*	Zone of *Meiocardia metavulgaris.*	Zone of *Mytilus nicobaricus.*	Zone of *Cardita tjidamarensis.*	Zone of *Cyrena craufurdi.*	Uncertain.
44 *Cardita protovariegata*, spec. nov.	●			●										
45 „ *tjidamarensis*, K. Martin.										●		●		
46 „ *viquesneli*, d'Archiac & Haime.		●		●						●	●			
47 „ *planicosta*, spec. nov.		●	●								●			
48 „ *cf. mutabilis*, d'Archiac & Haime.										●	●			●
49 *Crassatella dieneri*, spec. nov.										●	●			
50 „ *rostrata*, Lamarck.		●												
51 *Lucina neosquamosa*, spec. nov.				●										
52 „ *pagana*, spec. nov.				●			●							
53 „ *d'archiaciana*, spec nov.									●					
54 *Cardium protosubrugosum*, spec. nov.		●		●										
55 „ *minbuense*, spec. nov.		●		●		●					●			
56 *Cyrena kodoungensis*, spec. nov.													●	
57 „ *craufurdi*, Noetling.													●	
58 „ *petrolei*, Noetling.													●	
59 *Meiocardia protovulgaris*, spec. nov.			●	●										
60 „ *metavulgaris*, spec. nov.										●	●			●
61 *Petricola incerta*, spec. nov.			●											
62 *Venus protoflexuosa*, spec. nov.			●											
63 „ *granosa*, Sowerby.														●
64 *Cytherea erycina*, Lamarck.	●		●	●										
65 „ *yomaënsis*, spec. nov.			●											
66 *Dione protolilacina*, spec. nov.	●		●	●	●					●	●			
67 „ *arrakanensis*, spec. nov.				●										
68 „ *amygdaloides*, spec. nov.		●	●	●	●		●				●			
69 „ *dubiosa*, Noetling.								●	●					
70 „ *protophilippinarum*, spec. nov.	●	●	●	●	●	●	●	●		●	●			
71 *Tapes protolirata*, spec. nov.														●
72 *Dosinia protojuvenilis*, spec. nov.	●	●		●										

NAME OF SPECIES.	Zone of *Cytherea erycina.*	Zone of *Arivia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parallelipipedum prototortuosum.*	Zone of *Arca theobaldi.*	Zone of *Anoplotherium birmanicum.*	Zone of *Paracyathus caeruleus.*	Zone of *Cancellaria martiniana.*	Zone of *Dione dubiosa.*	Zone of *Meiocardia metavulgaris.*	Zone of *Mytilus nicobaricus.*	Zone of *Cardita tjidamarensis.*	Zone of *Cyrena crawfurdi.*	Uncertain.
73 *Tellina grimesi*, spec. nov.	●	●	●	●	●	·	·	·	·	●	●	·	·	·
74 " *protostriatula*, spec. nov.	·	·	·	●	●	·	·	·	·	·	·	·	·	·
75 " *protocandida*, spec. nov.	·	·	·	●	·	·	·	·	·	·	·	·	·	·
76 " *indifferens*, spec. nov.	·	·	·	●	·	·	·	·	·	·	·	·	·	·
77 " *foliacea*, Reeve.	·	●	●	●	●	·	·	·	·	·	·	·	·	·
78 " *hilli*, Noetling.	·	●	●	●	●	·	●	●	·	·	·	·	·	·
79 " *pseudohilli*, spec. nov.	·	·	·	●	·	·	·	·	·	·	·	·	·	·
80 *Gari natensis*, spec. nov.	·	·	·	●	·	·	·	·	·	·	·	·	·	·
81 " *protokingi*, spec. nov.	·	·	·	●	●	·	·	·	·	·	·	·	·	·
82 " *kingi*, Noetling.	·	·	·	·	·	·	●	●	·	●	·	·	·	·
83 " *deuterokingi*, spec. nov.	·	·	·	·	·	·	·	·	·	·	●	·	·	·
84 *Hiatula textilis*, spec. nov.	·	·	·	●	·	·	·	·	·	·	·	·	·	·
85 *Solecurtus exsulcatus*, spec. nov.	·	·	·	·	·	·	·	·	·	·	·	·	·	●
86 *Solen*, spec.	·	·	●	·	·	·	●	·	·	·	·	·	·	·
87 *Mactra protoreevesi*, spec. nov.	·	·	●	●	·	·	·	·	·	·	·	·	·	·
88 *Corbula socialis*, K. Martin.	·	·	●	●	●	·	·	·	·	·	·	·	·	·
89 " *rugosa*, Sowerby.	·	·	·	·	·	·	·	·	·	●	●	·	·	·
90 " *prototruncata*, spec. nov.	·	·	·	·	●	·	·	●	●	·	·	·	·	·
91 *Pholas orientalis*, Gmelin.	·	·	●	·	·	·	·	·	·	·	·	·	·	·
92 " *blanfordianus*, spec. nov.	·	·	●	·	·	·	·	·	·	·	·	·	·	·
GASTROPODA.														
93 *Dentalium junghuhni*, K. Martin.	·	·	·	●	·	·	·	·	·	·	●	·	·	·
94 " *bœttgeri*, spec. nov.	·	·	·	·	●	·	·	·	·	·	·	·	·	·
95 *Calliostoma blanfordi*, Noetling.	·	·	·	·	·	·	●	●	·	●	●	·	·	·
96 " *koenenianum*, spec. nov.	·	·	·	·	●	·	·	·	·	·	·	·	·	·
97 *Bassilissa lorioliana*, spec. nov.	·	·	·	·	●	·	·	·	·	●	●	·	·	·
98 *Turcica protomonilifera*, spec. nov.	·	·	·	·	●	·	·	·	·	●	·	·	·	·
99 *Trochus*, spec.	●	·	·	·	·	·	·	·	·	·	·	·	·	·
100 *Solarium nitens*, spec. nov.	·	·	●	·	·	·	·	·	·	·	·	·	·	·

NAME OF SPECIES.	Zone of *Cytherea erycina.*	Zone of *Arca humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parallelipipedum prototortuosum.*	Zone of *Arca theobaldi.*	Zone of *Anoplotherium birmanicum.*	Zone of *Paracyathus caeruleus.*	Zone of *Cancellaria martiniana.*	Zone of *Dione dubiosa.*	Zone of *Meiocardia metavulgaris.*	Zone of *Mytilus nicobaricus.*	Zone of *Cardita tjidamarensis.*	Zone of *Cyrena crawfurdi.*	Uncertain.
101 ***Solarium maximum***, Philippi.				•	•		•	•		•	•			
102 „ ***coniforme***, spec. nov.		•												
103 ***Torinia protodorsuosa***, spec. nov.					•			•						
104 „ ***buddha***, Noetling.							•	•						
105 ***Discohelix minuta***, Noetling.								•						
106 ***Scalaria spathica***, spec. nov.								•						
107 „ ***leptopleurata***, spec. nov.									•					
108 „ ***birmanica***, Noetling.				•				•						
109 „ ***irregularis***, Noetling.								•						
110 ***Turritella simplex***, Jenkins.				•	•						•			
111 „ ***acuticarinata***, Dunker.				•	•									•
112 „ ***affiniformis***, spec. nov.	•						•	•						
113 „ ***leiopleurata***, spec. nov.				•										
114 „ ***lydekkeri***, spec. nov.				•										•
115 „ ***angulata***, Sowerby.														•
116 „ ***spec.***				•										
117 ***Vermetus javanus***, K. Martin.	•	•		•										
118 ***Siliquaria***, spec. 1.							•							
119 „ spec. 2.						•					•			
120 ***Xenophora birmanica***, spec. nov.		•												
121 ***Calyptraea rugosa***, Noetling.		•	•		•		•	•			•			
122 ***Natica callosa***, Sowerby.	•	•		•	•		•	•						
123 „ ***obscura***, Sowerby.	•	•	•	•	•		•	•			•			
124 „ ***gracilior***, spec. nov.				•										
125 „ ***spec.***					•									
126 ***Sigaretus neritoideus***, Linné.	•			•			•				•			
127 ***Fossarus krausei***, spec. nov.					•									
128 ***Rimella crispata***, Sowerby, spec.					•						•			
129 ***Cypraea granti***, d'Archiac & Haime.							•	•		•	•			

NAME OF SPECIES.	Zone of *Cytherea erycina*.	Zone of *Aricia humerosa*.	Zone of *Pholas orientalis*.	Zone of *Parallelipipedum prototortuosum*	Zone of *Arca theobaldi*.	Zone of *Anoplotherium birmanicum*.	Zone of *Paracyathus caeruleus*.	Zone of *Cancellaria martiniana*.	Zone of *Dione dubiosa*.	Zone of *Meiocardia metavulgaris*.	Zone of *Mytilus nicobaricus*.	Zone of *Cardita tjidamarensis*.	Zone of *Cyrena crawfurdi*.	Uncertain.
130 *Aricia humerosa*, Sowerby, spec.	·	●	·	·	·	·	·	·	·	·	·	·	·	·
131 *Trivia smithi*, K. Martin.	·	·	·	·	·	·	●	·	·	·	·	·	·	·
132 *Cassis d'archiaci*, Noetling.	·	·	·	·	·	·	·	●	·	·	·	·	·	·
133 *Semicassis protojaponica*, spec. nov.	·	·	·	·	·	·	·	●	·	·	·	·	·	·
134 *Galeodea monilifera*, spec. nov.	·	·	·	·	●	·	·	·	·	●	●	·	·	·
135 *Oniscidia minbuensis*, Noetling.	·	·	·	·	·	·	·	●	·	·	·	·	·	·
136 *Ficula theobaldi*, Noetling.	·	·	·	·	·	·	●	●	·	●	●	·	·	·
137 „ *spec.*	·	·	●	●	·	·	·	·	·	·	·	·	·	·
138 *Triton neostriatulus*, spec. nov.	·	·	·	·	·	·	●	·	·	·	·	·	·	·
139 „ *pardalis*, Noetling.	·	·	·	·	●	·	●	●	·	·	·	·	·	·
140 „ *neocolubrinus*, spec. nov.	·	·	·	·	●	·	·	·	·	·	·	·	·	·
141 *Persona gautama*, spec. nov.	·	·	·	·	●	·	·	·	·	·	·	·	·	·
142 *Ranella prototubercularis*, spec. nov.	·	·	·	●	●	·	●	●	·	·	·	·	·	·
143 „ *elegans*, Beck.	●	●	·	●	·	·	·	·	·	·	·	·	·	·
144 *Eburna protoceylanica*, spec. nov.	●	·	·	·	●	·	·	·	·	·	·	·	·	·
145 *Fusus seminudus*, spec. nov.	·	●	·	·	·	·	●	●	·	·	·	·	·	·
146 „ *verbeeki*, K. Martin.	·	●	·	·	·	·	·	·	·	·	·	·	·	·
147 *Fasciolaria nodulosa*, Sowerby.	·	·	·	·	·	·	●	●	·	·	·	·	·	·
148 *Pyrula pugilina*, Born., spec.	●	·	·	·	·	·	·	·	·	·	·	·	·	·
149 „ *bucephala*, Lamarck.	·	·	·	·	·	·	·	·	·	·	●	·	·	·
150 „ *pseudobucephala*, spec. nov.	·	·	·	·	·	·	·	·	·	·	●	·	·	·
151 *Murex arrakanensis*, Noetling.	·	·	·	·	·	·	·	●	·	·	·	·	·	·
152 „ (?) *tchihatcheffi*, d'Arch. & Haime.	·	·	·	·	·	·	●	·	·	·	·	·	·	·
153 *Marginella scripta*, Reeve.	·	·	·	·	●	·	·	·	·	·	·	·	·	·
154 *Volvaria birmanica*, Noetling.	·	·	·	·	·	·	·	●	·	·	·	·	·	·
155 *Voluta ringens*, spec. nov.	·	·	·	·	·	·	·	●	·	·	·	·	·	·
156 „ *dentata*, Sowerby.	·	·	·	·	·	·	●	●	·	·	·	·	·	·
157 *Oliva rufula*, Duclos.	·	●	·	●	●	·	●	●	·	·	●	·	·	·
158 *Ancillaria cf. vernedei*, Sowerby.	●	●	●	·	·	·	·	·	·	·	·	·	·	·

NAME OF SPECIES.	Zone of *Cytherea erycina.*	Zone of *Aricia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parallelipipedum prototortuosum.*	Zone of *Arca theobaldi.*	Zone of *Anoplotherium birmanicum.*	Zone of *Paracyathus caeruleus.*	Zone of *Cancellaria martiniana.*	Zone of *Dione dubiosa.*	Zone of *Meiocardia metavulgaris.*	Zone of *Mytilus nicobaricus.*	Zone of *Cardita tjidamarensis.*	Zone of *Cyrena crawfurdi.*	Uncertain.
159 *Cancellaria neavolutella*, spec. nov.					●									
160 " *inornata*, spec. nov.					●									
161 " *pseudocancellata*, spec. nov.							●							
162 " *davidsoni*, d'Archiac.							●	●						
163 " *martiniana*, spec. nov.							●	●						
164 *Strioterebrum protomyuros*, spec. nov.					●									
165 " *unicinctum*, spec. nov.					●									
166 " *bicinctum*, K. Martin.					●									
167 *Terebum protoduplicatum*, spec. nov.					●									
168 " *smithii*, K. Martin.								●						
169 " *spec.*							●							
170 *Subula spec.*	●	●						●						
171 *Pleurotoma karenaica*, spec. nov.					●									
172 *Surcula feddeni*, Noetling.					●		●	●						
173 *Genota irravadica*, Noetling.								●			●			
174 *Clavatula munga*, spec. nov.				●										
175 " *fulminata*, Kiener.											●			
176 " *protonodifera*, spec. nov.								●			●			
177 *Drillia yenanensis*, Noetling.							●							
178 " *protointerrupta*, spec. nov.					●			●						
179 " *promensis*, spec. nov.					●									
180 " *protocincta*, spec. nov.					●									
181 *Conus literatus*, Linné.		●												
182 " *malaccanus*, Hwas.							●	●						
183 " *avaënsis*, spec. nov.	●	●	●	●	●					●	●			
184 " *yuleianus*, spec. nov.		●		●										
185 " *hanza*, spec. nov.				●										
186 " *protofurvus*, spec. nov.				●			●							
187 *Conus galensis*, spec. nov.							●							
188 *Ringicula turrita*, Martin.				●										

NAME OF SPECIES.	Zone of *Cytherea erycina*.	Zone of *Aricia humerosa*.	Zone of *Pholas orientalis*.	Zone of *Parallelipipedum prototortuosum*	Zone of *Arca theobaldi*.	Zone of *Anoplotherium birmanicum*.	Zone of *Paracyathus caeruleus*.	Zone of *Cancellaria martiniana*.	Zone of *Dione dubiosa*.	Zone of *Meiocardia metavulgaris*.	Zone of *Mytilus nicobaricus*.	Zone of *Cardita tjidamarensis*.	Zone of *Cyrena crawfurdi*.	Uncertain.
CRUSTACEA.														
189 *Balanus tintinnabulum*, Linné.	●	●	.	●	●	.	●	●	.	●	.	.	.	.
190 *Callianassa birmanica*, spec. nov.	.	.	.	●	●	.	●	●	.	●	●	.	.	.
191 *Calappa protopustulosa*, spec. nov.	.	.	.	.	.	.	.	.	.	.	●	.	.	●
192 *Ebalia sixtuberculata*, spec. nov.	.	.	.	.	.	.	.	.	.	.	.	.	.	●
193 *Neptunus spec.*	.	.	.	.	.	.	.	.	.	.	.	.	.	●
194 *Cancer spec.*	.	.	.	.	.	.	.	●	.	.	.	.	.	●
PISCES.														
195 *Oxyrhina pagoda*, spec. nov.	.	.	.	.	.	.	.	.	.	.	.	.	.	●
196 „ *spallanzanii*, Bonaparte.	.	.	.	.	.	.	●	●	.	●	●	.	.	.
197 *Alopias vulpes*, Gmelin.	.	●	.	.	.	.	.	.	.	.	.	.	.	●
198 *Carcharodon megalodon*, Agassiz.	.	.	.	.	.	.	.	.	.	.	.	.	.	●
199 *Hemipristis serra*, Agassiz.	.	.	.	.	.	.	.	.	.	.	.	.	.	●
200 *Galeocerdo spec.*	.	.	.	.	.	.	.	●	.	.	.	.	.	.
201 *Carcharias gangeticus*, M. and H.	.	.	.	.	.	●	●	●	.	●	●	.	.	.
202 *Myliobates spec.*	.	.	.	.	.	●	●	●	.	.	.	.	.	.
203 *Otolithus spec.*	.	.	.	.	.	.	●	.	.	.	.	.	.	.
204 *Siluroid gen.*	.	.	.	.	.	●	.	.	.	.	.	.	.	.
REPTILIA.														
205 *Python cf. molurus*, Linné.	.	.	.	.	.	●	.	.	.	.	.	.	.	.
206 *Crocodilus palustris*, Less.	.	.	.	.	.	●	.	.	.	.	.	.	.	.
207 *Gharialis gangeticus*, Gmel.	.	.	.	.	.	●	.	.	.	.	.	.	.	.
MAMMALIA.														
208 *Anoplotherium birmanicum*, spec. nov.	.	.	.	.	.	●	.	.	.	.	.	.	.	.

(B) The Fauna of the Yenangyoungian.

The contents of this list are condensed in the following table which shows the number of species of each class occurring in one and more horizons :—

Species occurring in	Anthozoa.	Echinoidea.	Pelecypoda.	Gastropoda.	Crustacea.	Vertebrata.
13 horizons	...	...	...	...	...	...
12 „	...	...	...	...	...	...
11 „	...	...	...	...	...	...
10 „	...	...	1	...	...	...
9 „	...	...	...	...	...	...
8 „	...	...	...	1	1	...
7 „	1	...	1	1	...	...
6 „	...	...	4	4	1	...
5 „	...	...	1	...	...	...
4 „	1	...	4	6	...	1
3 „	...	...	8	9	...	1
2 „	1		19	19	...	1
1 „	1	1	38	57	...	2

The table shows at once how small a number of species possess a large vertical range, while the larger majority are known to occur in one or two horizons only.

The small number of species belonging to other classes than the Gastropoda and Pelecypoda renders them of very inferior importance, and if we disregard them in the following discussion, such an omission will not materially affect the result.

The vertical distribution of the Pelecypoda and Gastropoda will best be realized if instead of the actual number, per cents. of the total are given, inasmuch as they allow of a better comparison.

These figures have been computed in the following table :—

Species occurring in	Pelecypoda.	Gastropoda.	TOTAL.
13 horizons	......	......	......
12 „	......	......	......
11 „	......	......	......
10 „	1·31%	1·04%	0·58%
9 „	......	......	......
8 „	......	1·04%	0·58%
7 „	1·31%	1·04%	1·16%
6 „	5·24%	4·16%	4·64%
5 „	1·31%	......	0·58%
4 „	5·24%	5·20%	5·22%
3 „	10·48%	9·36%	9·66%
2 „	24·89%	19·76%	22·04%
1 „	49·78%	59·28%	55·10%

These figures prove as distinctly as possible that the vertical range of the majority of species is a very short one ; over half occur in one horizon only, 22·04%

that is less than one quarter occur in two horizons, and from there the percentage rapidly decreases: 15·08% occur in three and four horizons, and only 7·54% and 6·96% are known to occur in five and more horizons.

These species are—

1. *Dione protophilippinarum*, spec. nov., in 10 horizons.
2. *Natica obscura*, Sow., in 8 horizons.
3. *Tellina grimesi*, spec. nov., in 7 horizons.
4. *Conus avaënsis*, spec nov., in 7 horizons.
5. *Pecten kokenianus*, spec. nov., in 6 horizons.
6. *Dione protolilacina*, spec. nov., in 6 horizons.
7. „ *amygdaloides*, spec. nov., in 6 horizons.
8. *Tellina hilli*, spec. nov., in 6 horizons.
9. *Solarium maximum*, Phil., in 6 horizons.
10. *Calyptraea rugosa*, Noetl., in 6 horizons.
11. *Oliva rufula*, Duel., in 6 horizons.
12. *Natica callosa*, Sow., in 6 horizons.
13. *Arca bistrigata*, Dunk., in 5 horizons.

To this list we may add ***Paracyathus caeruleus***, Dunc., ***Balanus tintinnabulum***, Lin., ***Callianassa birmanica***, spec. nov., bringing the total number of species which occur in more than four horizons up to 16. This is a very insignificant number which amounts to not more than 8·2% of the total number of species described from the ***Yenangyoungian***. If we examine the value of the different species we see that out of the whole number only five, *viz.*,—

Paracyathus caeruleus, Dunk.
Tellina grimesi, spec. nov.
„ *hilli*, spec. nov.
Solarium maximum, Phil.
Callianassa birmanica, spec nov.

are such species which can always be unmistakably recognized, the remaining eight exhibit more or less indifferent features, that is to say, unless very well preserved, a small change which would constitute a different species, is not noticed.

The great faunistic difference between two horizons which are not far distant from each other in the vertical sequence is exceedingly well illustrated by the two following instances.

I have dwelt in pages 18 and 19 on the stratigraphical position of the zones of ***Parallelipipedum prototortuosum*** and ***Arca theobaldi***; the following table shows the vertical distribution of the fossils in these two horizons; there are

	Common to both horizons.	Occurring only in the zone of *Parallelipipedum prototortuosum*.	Occurring only in the zone of *Arca theobaldi*.
Anthozoa	1	2	...
Echinoidea	1	1	...
Pelecypoda	11	23	
Gastropoda	8	15	26
Crustacea	2	...	...

It will be seen that out of a total of 98 species only 23 or 23·46°/₀ occur in both horizons, the majority being Pelecypoda, and if we examine these, we see that 7 belong to the above-mentioned group which occur in more than four horizons; on the other hand the zone of *Parallelipipedum prototortuosum* contains 41 species or 41·83°/₀ which do not occur in the zone of *Arca theobaldi*, the majority of these species being Pelecypoda, while the zone of *Arca theobaldi* contains 34 or 34·68°/₀ of species the majority of which are Gastropoda which do not occur in the zone of *Parallelipipedum prototortuosum*.

Not less instructive is the comparison of the zone of *Meiocardia metavulgaris* and *Mytilus nicobaricus*. The vertical distribution of this fauna is shown in the following list:—

	Common to both horizons.	Occurring only in the zone of *Meiocardia metavulgaris*.	Occurring only in the zone of *Mytilus nicobaricus*.
Anthozoa	1	...	...
Echinoidea	...	...	...
Pelecypoda	12	7	7
Gastropoda	7	1	13
Crustacea	1	...	...
Pisces	1	...	...

Out of a total of 50 species 22(=44°/₀) are common to both horizons, the majority of which are again Pelecypoda, mostly the same species which occur in more than four horizons. The zone of *Meiocardia metavulgaris* contains 8(=16°/₀) species which do not occur in the zone of *Mytilus nicobaricus*, while this zone is characterised by 20 (=40°/₀) species. In the following table these figures are arranged a little more distinctly; there are:—

	Common to two horizons.	Characteristic for the horizon.
Zone of *Parallelipipedum prototortuosum*, spec. nov.	23·46%	41·82%
Zone of *Arca theobaldi*, spec. nov.		34·68%
Zone of *Meiocardia metavulgaris*, spec. nov.	44·00%	16·00%
Zone of *Mytilus nicobaricus*, Reeve		40·00%

If it is permitted to take the average of these figures, we may say out of a given number of species occurring in two different horizons of the *Yenangyoungian*, 33·73°/₀ will be common to both, while each horizon contains 33·12°/₀ which are characteristic of it. But it must be understood that the chronological difference between the two horizons must not be too great, as will be seen at once if we compare the zone of *Parallelipipedum prototortuosum* and the zone of *Mytilus nicobaricus* both of which have only 12 species or 12·61°/₀ in common.

The result of this discussion is that under favourable circumstances, when there is no great vertical difference between two horizons, the proportion of species

common to both may be 33·72°/₀ out of the total fauna, but when there is a great vertical distance, the proportion may be 12·61°/₀ at the outside and can even sink below these figures, while the species characteristic for each horizon may be 34·18°/₀ in the average, but rise as high as 74·78°/₀.

It is obvious that under these circumstances the fossils are of very small correlative value, and if we should attempt to correlate the different horizons here distinguished by means of their fauna, not even a fairly accurate result would be obtained. Each horizon appears to contain a small number of species which it shares with the neighbouring beds, a still smaller number of species having a wider range, while the largest number is represented by species restricted to it.

The limited horizontal distribution may also to some extent be responsible for the small number of species which two horizons occurring in the same positions in the sequence, but at different localities, have in common.

We may therefore suppose that in the *Yenangyoungian* we have a sequence of rapidly changing faunas, of a limited horizontal range. A few species persisted, others may occur in two different horizons, without being known from the intermediate beds. Under favourable circumstances a fauna thrived at one locality over a short horizontal distance; for reasons irrelevantly which, the majority of that fauna died out, and in the next higher bed we find at the same locality a perfectly different fauna, containing only a few species of the earlier one.

Such changes can only be explained by the supposition that the younger fauna immigrated from somewhere else to the place of the older one, only to be replaced in its own turn by another fauna. This unsettled state of the fauna of the *Yenangyoungian* will be further confirmed by certain peculiarities of the Pelecypoda.

(C) *The Fauna of the Promeian.*

A few words are sufficient to deal with the fauna occurring in the zone of *Anoplotherium birmanicum.* The invertebrates are all such species which it shares in common with the zones of *Paracyathus caeruleus* or *Cancellaria martiniana,* thus proving unmistakably the faunistic relationship with the *Yenangyoungian.* In fact, the few species that have been recognized are chiefly such that occur in more than four horizons.

On the other hand the vertebrata, with the exception of the fishes, have not been found in any higher bed yet. Whether they occur in lower beds I am unable to say, but if it were permitted to form a conclusion from the absolutely unfossiliferous samples of the bore holes, the answer would be negative. It is, however, certain that the horizontal range of the zone of *Anoplotherium birmanicum* is a very limited one, because no trace of this horizon has been discovered in any of the neighbouring pit wells, and the absence of fossiliferous beds in the drilled bore holes might after all be only an apparent one. Whether, therefore, other fossiliferous horizons will in future be discovered in the *Promeian* or not, cannot be stated with certainty, but the probability is in favour of such a view, particularly when the strata of the *Prome*-sandstone will be carefully searched.

The fauna of the *Promeian*, little as we know about it, would thus show the same features as that of the *Yenangyoungian*, namely, a very limited vertical and horizontal range.

3.—Composition of the fauna.

(*A*) *General Remarks.*

After the determination of the species had progressed for a certain time, I noticed that the fauna was composed of very different elements, a view which might have been anticipated, considering its geological and geographical position. *A priori* we might have expected species, related to such of the Eocene of India, and others more or less related to those inhabiting the Indian Ocean; we might have further expected species identical with the younger Tertiary beds of western India, others identical with those of Java or Sumatra, and to judge from the results Professor Martin arrived at from the study of the tertiary fossils of Java, it would have been very strange if a relationship with the Miocene of Europe existed. However, in order not to prejudice my mind by auto-suggestion, I refrained from taking notice of any observation that might agree with these views, while the determination of species was progressing, trying to take as impartial an opinion of each species as possible, and I think I have in this way avoided the danger of determining the species under the impression of a previously fixed idea. After the determination had been completed, the various notes were collected and they proved to be of unusual interest.

On the following pages 181 species=88·8°/₀ of total fauna of the *Yenangyoungian*, of Pelecypoda and Gastropoda have been described, of which 14 only could not be specifically determined. These species are therefore omitted, and for obvious reasons the Anthozoa, Echinoidea, Crustacea and Vertebrata have also been disregarded.

The remaining 167 species of Pelecypoda and Gastropoda can be divided into two classes, *viz.*—

(*a*) Species representing types which do not exist among the fauna of the Indian Ocean; this class would therefore form the "extinct" species with reference to the fauna of the Indian Ocean, but for reasons presently seen, I reject this term and propose the name of *Palæogene* species for this group.

(*b*) Species which are either identical with species inhabiting the Indian Ocean or which in some way or other could be referred to such species; the term *Neogene* species is suggested for this group.

(*a*) Palæogene Species.

I very soon discovered that the palæogene species do by no means represent a harmonious group, but that they are made up of various, rather heterogenous elements, and four distinct classes could be discerned.

Of a large number of species no relatives, either fossil or living, could be traced; it is very probable that this group represents the *indigenous* element, that

is to say, species which are either direct descendants of species occurring in the Eocene of India-Burma, or have their nearest relatives in the same formation. How far this view is correct can only be ascertained after the Eocene fauna of Burma and India is fully known.

A second, though smaller group, being about one-third of the number of the former, exhibited the closest relationship with species occurring in the Eocene of Paris. I term this group *Gallic* types.

The third group, being half the number of the first, is closely related to species which, according to our present knowledge, do not inhabit the Indian Ocean, but live in China, Japan, the Philippine Islands and Australia. The term *Pacific* types is used for this group.

The fourth and smallest group represents species, the relatives of which live neither in the Indian Ocean nor the Pacific Province, but appear to be limited to the Mediterranean, and *Mediterranean* types would be an appropriate designation.

The fifth group, which contains a single species which could not be classified, is of course only a makeshift, which would disappear if the characters of this species were better known.

(b) Neogene Species.

Four groups could be distinguished in this class, though they are not so sharply defined as those of the palæogene species. In several instances it remained somewhat doubtful to which class a certain species should be assigned, and much is left to personal opinion and palæontological tact, when such doubtful cases have to be decided.

The first group represents those which are *identical* with species inhabiting the Indian Ocean; its number is about one-third of the indigenous species.

The second group represents those which, for some reason or other presently explained, could not be considered as exactly identical with species inhabiting the Indian Ocean; these are the *sub-identical* species, their number being the same as those of the identical species.

The third and smallest group represents those which unquestionably represent a permanent juvenile stage of species inhabiting the Indian Ocean, the *evolutionary* species.

The fourth group includes all those which, for some reason or other, could not be included in one of the former classes.

If we assume the number of the indigenous species to be 100, the proportion by which the other classes contribute towards the composition of the fauna would be as follows:—

1. Indigenous types .	100
2. Gallic types . .	37
3. Pacific types . .	50
4. Mediterranean types .	3
5. Identical species .	30
6. Sub-identical species .	30
7. Evolutionary species .	13

On the following pages I intend to discuss these seven classes, firstly from a palæontological and secondly from a geological point of view, dealing with their vertical distribution in the horizons distinguished.

(B) *Palæontological Considerations.*

(a) PALÆOGENE SPECIES.

1. *Indigenous types.*—The following is the list of species of which no relatives, either living or fossil, could be traced, and which for this reason are assumed to be species which have the closest relationship with species occurring in the Eocene of India and Burma. This view is corroborated by another observation; a glance through the list will show that only 7 species out of the total of 62 occur also in Java; the remainder has so far not been observed outside India or Burma. Pelecypoda and Gastropoda contribute in unequal shares to make up the total, though the latter are with 37 species not much in excess of the former with 25 species, at least as regards absolute numbers, but if computed in per cents. we see that the Gastropoda form exactly 60°/₀ and the Pelecypoda only 40°/₀ of the total. We shall see later on that this disproportion between the two classes occurs more frequently, and a theory to explain it will be given on page 67. There is nothing more to be said about this group, except that it will probably be of great importance when the fauna of the older tertiary beds of India will be examined.

List of indigenous types.

1. *Ostrea peguensis*, spec. nov.
2. *Lima griesbachiana*, spec. nov.
3. *Vulsella lingua-tigris*, spec. nov.
4. *Modiola buddhaica*, spec. nov.
5. „ *pseudobuddhaica*, spec. nov.
6. *Arca oldhamiana*, spec. nov.
7. „ *yawensis*, spec. nov.
8. „ *myoënsis*, spec. nov.
9. „ *nannodes*, K. Martin.
10. „ *pecthensis*, d'Archiac and Haime.
11. *Nucula phayreiana*, spec. nov.
12. *Leda birmanica*, spec. nov.
13. „ *virgo*, K. Martin.
14. „ *avaënsis*, spec. nov.
15. *Cardita viquesneli*, d'Archiac and Haime.
16. „ *planicosta*, spec. nov.
17. *Lucina d'archiaciana*, spec. nov.
18. *Cardium minbuense*, spec. nov.
19. *Petricola incerta*, spec. nov.
20. *Cytherea yomaënsis*, spec. nov.
21. *Dione arrakanensis*, spec. nov.
22. „ *amygdaloides*, spec. nov.
23. „ *dubiosa*, Noetling.

24. *Hiatula textilis*, spec. nov.
25. *Corbula rugosa*, Sowerby.
26. *Dentalium bœttgeri*, spec. nov.
27. *Calliostoma blanfordi*, Noetling.
28. „ *kœnenianum*, spec. nov.
29. *Basilissa lorioliana*, spec. nov.
30. *Solarium coniforme*, spec. nov.
31. *Torinia buddha*, Noetling.
32. *Scalaria leptopleurata*, spec. nov.
33. „ *irregularis*, Noetling.
34. *Turritella simplex*, Jenkins.
35. „ *affiniformis*, spec. nov.
36. *Cypræa granti*, Sowerby.
37. *Aricia humerosa*, Sow., spec.
38. *Trivia smithi*, K. Martin.
39. *Cassis d'archiaci*, Noetling.
40. *Galeodea monilifera*, spec. nov.
41. *Oniscidia minbuensis*, Noetling.
42. *Ficula theobaldi*, Noetling.
43. *Triton pardalis*, Noetling.
44. *Persona gautama*, spec. nov.
45. *Fusus verbecki*, K. Martin.
46. *Murex arrakanensis*, Noetling.
47. „ (?) *tchihatcheffi*, d'Archiac and Haime.
48. *Voluta ringens*, spec. nov.
49. *Cancellaria inornata*, spec. nov.
50. „ *martiniana*, spec. nov.
51. *Strioterebrum unicinctum*, spec. nov.
52. „ *bicinctum*, spec. nov.
53. *Terebrum smithi*, K. Martin.
54. *Pleurotoma karenaica*, spec. nov.
55. *Surcula feddeni*, Noetling.
56. *Genota irravadica*, Noetling.
57. *Clavatula munga*, spec. nov.
58. *Drillia yenanensis*, Noetling.
59. „ *promensis*, spec. nov.
60. *Conus yulcianus*, spec nov.
61. „ *galensis*, spec. nov.
62. *Ringicula turrita*, K. Martin.

2. *Gallic types.*—This group includes the following 23 species, all of which bear a very strong resemblance to species occurring in the Eocene of Paris, without being, however, directly identical with any one of them. The grade of this relationship could not be ascertained, because for such a purpose a large collection of fossils from the Eocene of Paris would be required. It is, however, certain that it varies a good deal; in some instances like *Triton neastriatulus*, it is difficult to discover a difference, while in others the difference is more marked. In a few species it could not be decided which of two species is the one nearer related; in this case the two species have been mentioned.

List of Gallic types.

Name of species.	Name of nearest relative.	Reference.
1. *Ostrea promensis*, spec. nov.	*Ostrea multicostata*, Desh. *Ostrea flabellula*, Lmk.	Desh. Coq., pl. LVII, figs. 3, 4, 5, 6. Desh. Coq., pl. LXIII, figs. 5, 6, 7.
2. " *papyracea*, spec. nov.	*Ostrea simplex*, Desh.	Desh. Coq., pl. LVII, fig. 7, pl. LIX, figs. 11, 12, pl. LX, figs. 3, 4.
3. *Pecten kokenianus*, spec. nov.	*Pecten reconditus*, Sol.	Wood, Eoc. Moll., pl. IX, fig. 3, *a-d*.
4. " *irravadicus*, spec. nov.	" *lucidus*, Phil.	Desh. Anim., pl. LXXIX, figs. 15, 16.
5. *Lucina pagana*, spec. nov.	*Lucina squamula*, Desh.	Desh. Coq., pl. XVII, figs. 17, 18.
6. " *neasquamosa*, spec. nov.	" *squamosa*, Lmk.	Desh. Coq., pl. XVII, figs. 12, 13, 14.
7. *Tellina grimesi*, spec. nov.	*Tellina sinuata*, Lmk.	Desh. Coq., pl. XI, figs. 15, 16.
8. *Solarium nitens*, spec. nov.	*Solarium picteti*, Desh. *Solarium bistriatum*, Desh.	Desh. Anim., pl. XL, figs. 32, 33, 34. Desh. Coq., pl. XXV, figs. 19, 20.
9. *Scalaria spathica*, spec. nov.	*Scalaria multilamella*, Bast.	Desh. Coq., pl. XXII, figs. 15, 16.
10. *Turritella acuticarinata*, Dunk	*Turritella fasciata*, Lmk.	Desh. Coq., pl. XXXIX, figs. 1-20, pl. XXXVIII, figs. 13, 14, 17, 18.
11. " *leiopleurata*, spec. nov.	" *dixoni*, Desh.	Desh. Anim., pl. XIV, figs. 12, 13.
12. " *lydekkeri*, spec. nov.	" *sulcifera*, Desh.	Desh. Coq., pl. XXXV, figs. 5, 6, pl. XXXVI, figs. 3, 4, pl. XXXVII, figs. 19, 20.
13. " *angulata*, Sow.	" *carinifera*, Desh.	Desh. Coq., pl. XXXVI, figs. 1, 2.
14. *Vermetus javanus*, K. Martin.	*Siliquaria multistriata*, Desh.	Desh. Anim., pl. X, figs. 1, 2.
15. *Fossarus krausei*, spec. nov.	*Nerita pentastoma*, Desh.	Desh. Coq., pl. XIX, figs. 13, 14. Desh. Anim., pl. LXVI, figs. 7, 8, 9.
16. *Triton neastriatulus*, spec. nov.	*Triton striatulus*, Lmk. sp.	Desh. Coq., pl. LXXX, figs. 13, 14, 15.
17. " *neacolubrinus*, spec. nov.	" *colubrinus*, Lmk.	Desh. Coq., pl. LXXX, figs. 22, 23, 24.
18. *Fusus seminudus*, spec. nov.	*Fusus conjunctus*, Desh.	Desh. Coq., pl. LXX, figs. 16, 17.
19. *Volvaria birmanica*, Noetl.	*Volvaria acutiuscula*, Sow.	Desh. Coq., pl. XCV, figs. 7, 8, 9.
20. *Voluta dentata*, Sow.	*Voluta mutata*, Desh.	Desh. Coq., pl. XCII, figs. 1, 2.
21. *Cancellaria neavolutella*, spec. nov.	*Cancellaria volutella*, Lmk.	Desh. Coq., pl. LXXIX, figs. 19, 20, 21.
22. " *davidsoni*, d'Arch. and Haime.	" *evulsa*, Sol.	Desh. Coq., pl. LXXIX, figs. 27, 28.
23. *Conus avaënsis*, spec. nov.	*Conus diversiformis*, Desh.	Desh. Coq., pl. XCVIII, figs. 9, 10, 11, 12.

The remarkable feature of this fauna is the preponderance of the Gastropoda, which are more than double the number of the Pelecypoda, a fact which is the more curious, because, if the total of the Palæogene species is considered, Pelecypoda and Gastropoda contribute almost exactly the same share.

The occurrence of the Gallic types in the fauna of the *Yenangyoungian* is of the greatest interest, and the question how we are to account for this remarkable feature is not easy to answer. Two theories only are possible.

We may assume that the Eocene fauna had a very large geographical range, that is to say, the same fauna occurred simultaneously in the Eocene of France and India. This theory finds a strong support in some facts we know about the Eocene fauna of India, however few they may be. I myself have described the remarkable occurrence of *Velates schmiedeliana*, Chem. sp., from Burma, and I dwelt on its wide geographical range it being distributed over an enormous area, ranging, roughly speaking, from 0° Long. to 94° Long. E.[1] Messrs. d'Archiac and Haime mention quite a number of species of *Nummulites* as identical with those from France. On the other hand, Messrs. Duncan and Sladen have arrived at the conclusion that the Anthozoa and Echinoidea of the Ranikotian and Khirtharian are distinctly different from those of the Eocene of Europe. These views being in direct opposition it would be useless to speculate any more as to the character of the Indian Eocene fauna as the question will best be solved by its examination. I may, however, add that it would appear very strange, if an identical fauna existed in France and India during the Eocene period, at a time when most probably already well-defined geographical provinces existed.

The other theory is based on the migration of species. We may suppose that the fauna which lived during the Eocene period in France gradually migrated in eastern direction, and that during this migration, which took place in horizontal as well as vertical direction, that is to say, from west towards east and from the Eocene to the Miocene, the species underwent certain changes; they eventually assumed the shape in which they occur in the Miocene of Burma, and, though distinctly different from their Eocene ancestors, still preserve sufficient of their features to give them the hall-mark of their European Eocene home.

This theory is in direct opposition to that of Semper,[2] who holds that during the Eocene period an oceanic current was directed from India to Europe, and I think he supposes that a migration of species took place in the direction of this current, that is to say, just the opposite way as I assume. I do not wish to enter into a discussion of Dr. Semper's theory, but the data available with regard to the fauna of the Indian Eocene on which I think Dr. Semper's theory is chiefly based, are not reliable enough to base on such a far reaching theory. My view fully corroborates, however, Jenkin's[3] theory, who I believe was the first who promulgated the theory of an eastern migration of European species, in order to explain the relationship of the fauna of the Indian Ocean with the Miocene of

[1] Records Geolog. Survey of India, 1894, Vol. XXVII, pt. 3, page 106.
[2] Zeitschr. der deutsch. Geolog. Gesellsch. 1896, Vol. XLVIII, page 310.
[3] Quart. Journ. Geolog. Soc. of London, 1864, Vol. XX, page 61.

Europe. The only difference in our views, is the proof that this migration commenced earlier than assumed by Jenkins. My theory, assuming a migration in eastern direction, is supported by some exceedingly good facts. We shall presently see that a strong general relationship exists between the fauna of the *Yenangyoungian* and that of China, Japan and the Philippines, but more important is the observation with regard to the relationship of *Lucina pagana*, spec. nov., and *Lucina neasquamo sa*, spec. nov.

Lucina pagana, spec. nov., represents undoubtedly the nealogic stage of *Lucina philippinarum*, Reeve, a species which apparently does not occur in the Indian Ocean, but only eastwards of Singapore as far as the Philippines. On the other hand *Lucina pagana*, spec. nov., bears the closest relationship to *Lucina squamula*, Desh., from the Paris Eocene.

Perhaps still better proved is the relationship between *Lucina squamosa*, Lmk., *Lucina neasquamosa*, spec. nov., and *Lucina venusta*, Reeve. *Lucina neasquamosa* is so similar to *Lucina squamosa*, Lmk., from the Eocene of Paris that it is almost difficult to discover any differences; on the other hand *Lucina neasquamosa* is so similar to *Lucina venusta*, Reeve, from the Philippines, that the relationship of these two species can hardly be denied.

Both these species seem therefore to indicate a migration from west to east, which has been going on from the Eocene to the recent period; and the following diagrams will illustrate this view.

	France.	Burma.	Philippines.	France.	Burma.	Philippines.
Recent .	...	...	*Lucina philippinarum.*	...	...	*Lucina venusta.*
Miocene .	...	*Lucina pagana.*	...	...	*Lucina neasquamosa.*	...
Eocene .	*Lucina squamula.*	...	...	*Lucina squamosa*	...	...

A further proof is given by the occurrence of the genus *Basilissa*; this enus which has hitherto only been known from the recent fauna of Japan and the Eocene fauna of Paris is unmistakably represented by *Basilissa lorialiana*, spec. nov., from Burma.

If a certain genus X which has hitherto been known to occur in two countries, A and C only, in two vertically succeeding beds A′ and C′, is suddenly found in another country B half way between A and C in a bed B′ which holds an intermediate position between A′ and C′, the notion that this genus X migrated from A to C, ascending at the same time in vertical direction from A′ to C′ is well founded. The facts here recorded are fully in harmony with the known similarity between the Eocene fauna of France and the recent fauna of Japan. In fact, according to this view one ought to have *a priori* expected the occurrence of species related to such from the Eocene of Paris, and others related to such from the China-Japanese seas in the Miocene of Burma.

It is perhaps this observation, though not recognition of the Gallic element in the fauna of Java and Sumatra which led Bœttger to assume the views expressed in his memoir.[1] It would certainly be exceedingly interesting, if the Miocene fauna of Java and Sumatra would be examined, in order to ascertain whether the Gallic element exists among this fauna, as I believe, or not.

3. *Pacific types.*—The species included in this group amounting to 31 in all[2] are characterized by a great relationship to species inhabiting the western part of the Pacific Ocean from Japan to Australia, but which apparently do not occur among the fauna of the Indian Ocean, and though recent species to some degree are extinct with reference to the fauna of the Indian Ocean. The degree of relationship varies a good deal: some species are only distinguished by a smaller shell and a more delicate ornamentation from their living relatives, others represent unquestionably permanent juvenile stages, while others are most probably the ancestors from which certain species living now in the above region have evolved. These species are :—

List of Pacific Types.

Name of species.	Name of nearest relative.	Reference.
1. *Avicula suessiana*, spec. nov.	*Avicula electrina*, Rve., Malacca.	Reeve, Mon. of *Avicula*, pl. XVI, fig. 62.
2. *Arca thayetensis*, spec. nov.	*Arca gubernaculum*, Rve., Philippines.	Reeve, Mon. of *Arca*, pl. X, fig. 58.
	Arca japonica, Rve., Japan .	Reeve, Mon. of *Arca*, pl. V, fig. 32.
3. „ *bataviana*, K. Martin.	*Arca symmetrica*, Rve. } Philippines.	Reeve, Mon. of *Arca*, pl. XVII, fig. 117.
	Arca sculptilis, Rve. } Philippines.	Reeve, Mon. of *Arca*, pl. XVII, fig. 118.
4. *Parallelipipedum prototortuosum*, spec. nov.	*Parallelipipedum tortuosum*, Lin. sp., China.	Reeve, Mon. of *Arca*, pl. XIII, fig. 86.
5. *Cardita scabrosa*, spec. nov.	*Cardita crassicosta*, Lmk., Philippines.	Reeve, Mon. of *Cardita*, pl. II, fig. 7.
6. „ *tjidamarensis*, K. Martin.	*Cardita pica*, Rve., Philippines	Reeve, Mon. of *Cardita*, pl. II, fig. 8.
7. *Crassatella dieneri*, spec. nov.	*Crassatella jubar*, Rve., Philippines.	Reeve, Mon. of *Crassatella*, pl. II, fig. 11.
8. *Lucina neasquamosa*, spec. nov.	*Lucina venusta*, Phil., Philippines.	Reeve, Mon. of *Lucina*, pl. III, fig. 15.
9. „ *pagana*, spec. nov.	*Lucina philippinarum*, Ham., Philippines.	Reeve, Mon. of *Lucina*, pl. IV, fig. 18.
10. *Cyrena crawfurdi*, Noetl.	*Cyrena sumatrensis*, Sow., Sumatra.	Reeve, Mon. of *Cyrena*, pl. XIII, fig. 62.
11. „ *petrolei*, Noetl.		
12. *Meiocardia protovulgaris*, spec. nov.	*Meiocardia vulgaris*, Rve. sp., China.	Reeve, Mon. of *Isocardia*, pl. I, fig. 2.
13. „ *metavulgaris*, spec. nov.		

[1] Bœttger, Tertiärformation von Sumatra, Palæontographica, Suppl. 1880.

[2] The true absolute figure would only be 29, because *Lucina pagana* and *Lucina neasquamosa*, which have already been counted among the Gallic types, appear here again.

Name of species.	Name of nearest relative.	Reference.
14. *Venus protoflexuosa*, spec. nov.	*Venus flexuosa*, Linné, China	Reeve, Mon. of *Venus*, pl. XXI, fig. 99.
15. *Dione protolilacina*, spec. nov.	*Dione lilacina*, Lmk., Australia	Reeve, Mon. of *Dione*, pl. I, fig. 5.
16. *Dosinia protojuvenilis*, spec. nov.	*Dosinia juvenilis*, Gmel., Philippines.	Reeve, Mon. of *Artemis*, pl. I, fig. 6.
17. *Tellina protostriatula*, spec. nov.	*Tellina striatula*, Lmk., Philippines.	Reeve, Mon. of *Tellina*, pl. VIII, fig. 34.
18. „ *protocandida*, spec. nov.	*Tellina candida*, Lmk., China	Reeve, Mon. of *Tellina*, pl. V, fig. 21.
19. „ *indifferens*, spec. nov.	*Tellina triangularis*, Chemn., China.	Reeve, Mon. of *Tellina*, pl. XXV, fig. 136.
20. „ *kili*, Noetl.	*Tellina rostrata*, Lin., Philippines.	Reeve, Mon. of *Tellina*, pl. XVII, fig. 83.
21. „ *pseudokili*, spec. nov.	*Tellina rostellum*, Han. } Philippines.	Reeve, Mon. of *Tellina*, pl. XVII, fig. 85.
	Tellina planispinosa, Sow. } Philippines.	Reeve, Mon. of *Tellina*, pl. XXXV, fig. 196.
22. *Gari nalensis*, spec. nov.	*Gari puella*, Desh., Australia	Reeve, Mon. of *Psammobia*, pl. I, fig. 2.
	Gari corrugata, Desh., Philippines.	Reeve, Mon. of *Psammobia*, pl. II, fig. 9.
23. *Solecurtus exsulcatus*, spec. nov.	*Solecurtus exaratus*, Phil., China.	Reeve, Mon. of *Solecurtus*, pl. I, fig. 1.
24. *Mactra protoreevesi*, spec. nov.	*Mactra reevesi*, Desh., Malacca	Reeve, Mon. of *Mactra*, pl. XVII, fig. 92.
25. *Pholas blanfordianus*, spec. nov.	*Pholas manillae*, Sow., Philippines.	Reeve, Mon. of *Pholas*, pl. VIII, fig. 31.
26. *Turcica protomonilifera*, spec. nov.	*Turcica monilifera*, Adams, Australia.	H. & A. Adams, Gen. of Moll., Vol. I, pl. 48, fig. 3.
27. *Scalaria birmanica*, Noetl.	*Scalaria delicatula*, Crosse, Australia.	Reeve, Mon. of *Scalaria*, pl. XV, 115.
28. *Calyptraea rugosa*, Noetl.	*Calyptraea dormitoria*, Rve., Philippines.	Reeve, Mon. of *Calyptraea*, pl. II, fig. 5.
29. *Semicassis protojaponica*, spec. nov.	*Cassis japonica*, Rve., Japan.	Reeve, Mon. of *Cassis*, pl. IX, fig. 23.
30. *Conus protofurvus*, spec. nov.	*Conus furvus*, Rve., Philippines	Reeve, Mon. of *Conus*, pl. XIII and XI, fig. 69.
31. *Conus hanza*, spec. nov.	*Conus sinensis*, Sow., China	Reeve, Mon. of *Conus*, pl. XV, fig. 76.

The disproportion of Pelecypoda and Gastropoda is the striking feature of this list, the former greatly exceeding the latter; thus just the reverse takes place as we have noticed in the Gallic types. In that group the proportion of Pelecypoda to Gastropoda was 1·3 : 24, in this group it is 4·16 : 1. This is the more remarkable, because, as already stated, the proportion of Pelecypoda to Gastropoda is almost 1 : 1 among both the total of the palæogene and neogene species.

Among the Pacific types two species are of particular interest, because they represent unquestionably species from which new ones have evolved; these are *Parallelipipedum prototortuosum*, spec. nov., and *Meiocardia protovulgaris*, spec. nov.

The first named species represents that peculiar group of contorted *Arcæ*, for which the rather long name of *Parallelipipedum* has been chosen. No representatives of this genus are known from Europe, and it seems that this genus first appears in

the Miocene of Western India and Burma; it was probably very short lived in Burma, but in Western India it existed apparently longer, because it occurs in the Pleistocene deposits of the Mekran coast. It must have then died out, for it certainly does not occur among the fauna of the Indian Ocean,[1] but eastwards of Singapore it is now represented by the only living species *Parallelipipedum tortuosum*, Reeve, which has undoubtedly evolved from the Miocene *Parallelipipedum prototortuosum*.

A similar, and not less interesting instance is that of *Meiocardia protovulgaris*, spec. nov., and *Meiocardia metavulgaris*, spec. nov. The genus *Meiocardia* has been established for a few, peculiarly shaped species, which have formerly been classified among the genus *Isocardia;* the living representatives are at present restricted to the Chinese Sea, but it is very probable that it was largely represented in earlier periods, because many of the so-called *Cypricardiae* probably belong to the genus *Meiocardia*. In Burma it is first represented by *Meiocardia protovulgaris* in the zones of *Pholas orientalis* and *Parallelipipedum prototortuosum*. This species is triangular in shape, having a rather small index and delicate concentric striæ as ornamentation; in the younger zone of *Meiocardia metavulgaris*, the shape has become more elongate; the index therefore larger and the surface is covered with coarse concentric wrinkles. The genus seems then to have died out in India, but in Java it is represented by the Pleistocene *Meiocardia subcumingii*, Woodward, and at present it occurs only in three species, which apparently differ little from each other, and of which *Meiocardia vulgaris*, Reeve, is unquestionably the direct descendant of *Meiocardia metavulgaris*, having the same elongate shape, but strong concentric ribs, instead of coarse wrinkles.

These instances are sufficient to prove the connection between the Miocene fauna of Burma and that inhabiting the western coasts of the Pacific, a fact which can only be explained by migration.

4. *Mediterranean types.*—This group includes a very small number of species, the nearest relatives of which inhabit at present the Mediterranean, and which are unquestionably not represented among the present fauna of the Indian Ocean.

List of Mediterranean types.

Name of species.	Name of nearest living relative.	Living specimen compared.
1. *Discohelix minuta*, Noetl.	*Discohelix zanclea*, Phil.	Not compared.
2. *Cancellaria pseudocancellata*, spec. nov.	*Cancellaria cancellata*, Lmk.	Indian Museum from Algiers.

Both species are represented by a single specimen only, no others having been found, and this seems certainly a proof for their great scarcity.

[1] I am unable to say whether it perhaps still exists among the fauna of the Persian Gulf.

The occurrence of this element is as puzzling as that of the Gallic types, and if a rash conclusion were drawn from the occurrence of this particular type, an entirely false opinion would be arrived at. One might assume that this type, occurring in the Miocene of Burma, but not in the fauna of the Indian Ocean, migrated from east to west, thus indicating a direction of migration fully in opposition to the one above proved.

Another explanation can, however, be given which is perfectly in harmony with the theory of the migration from west to east. The nearest relatives of both species occur in the Miocene of Europe; whether an Eocene ancestor of *Cancellaria cancellata* will be found I am unable to say, but *Discohelix zanclea* had certainly an eocene predecessor. If we suppose that both types existed during the Eocene period in Europe and some of their representatives migrated with other species towards east, where they died out with the end of the Miocene period, while they persisted in Europe, up to the present time, we have a perfectly satisfactory explanation for the occurrence of this remarkable element in the Miocene fauna of Burma, without being in contradiction to the conclusions arrived at, from the study of other groups.

The number of these species is unfortunately very small, but it may not be too rash a conclusion, if we assume that a large number of Mediterranean types occurs in the Miocene of Western India.

5. *Species not classified.*—This group calls for no further remarks; it contains a single species only, *Ostrea promensis*, var., which is too ill-preserved to allow of any definite opinion as to which of the previous groups it should be assigned to. All that can be said about this species is, that it bears no similarity or relationship to any of the species of *Ostrea* living in the Indian Ocean, and perhaps represents a Gallic type.

(*b*) NEOGENE SPECIES.

1. *Identical species.*—This group includes only such species which after a careful examination could be pronounced to be identical with species inhabiting the Indian Ocean. The list is rather a meagre one giving only 19 species, which show an almost equal proportion of Pelecypoda and Gastropoda, the latter being slightly in excess of the former.

List of identical species.

Name of species.	Reference.	Recent specimen compared from.
1. *Mytilus nicobaricus*, Chemn.	Reeve, Mon. of *Mytilus*, pl. IX, fig. 42.	No recent specimens compared.
2. *Arca bistrigata*, Dunk.	......	Indian Museum.
3. *Crassatella rostrata*, Lmk.	Reeve, Mon. of *Crassatella*, pl. II, fig. 10.	Ditto.
4. *Venus granosa*, Sow.	......	Ditto.

Name of species.	Reference.	Recent specimen compared from.
5. *Cytherea erycina*, Favanne	Reeve, Mon. of *Dione*, pl. I, fig. 3.	Indian Museum.
6. *Tellina foliacea*, Linné	Reeve, Mon. of *Tellina*, pl. III, fig. 11.	Ditto.
7. *Pholas orientalis*, Gmelin.	Reeve, Mon. of *Pholas*, pl. II, fig. 5.	Ditto.
8. *Dentalium junghuhni*, K. Martin.	*Dentalium magnificum*	Ditto.
9. *Solarium maximum*, Philippi	Reeve, Mon. of *Solarium*, pl. I, fig. 4.	Ditto.
10. *Sigaretus neritoideus*, Linné	Reeve, Mon. of *Sigaretus*, pl. I, fig. 5.	Ditto.
11. *Rimella crispata*, Sow.	Reeve, Mon. of *Rostellaria*, pl. III, fig. 8.	Ditto.
12. *Ranella elegans*, Beck	Reeve, Mon. of *Ranella*, pl. V, fig. 22.	Ditto.
13. *Pyrula pugilina*, Born spec	Reeve, Mon. of *Pyrula*, pl. I, fig. 1.	Ditto.
14. „ *bucephala*, Lmk. spec.	Reeve, Mon. of *Pyrula*, pl. VII, fig. 24.	No recent specimens compared.
15. *Marginella scripta*, Hinds.	Reeve, Mon. of *Marginella*, pl. XIV, fig. 58.	Indian Museum.
16. *Oliva rufula*, Ducl.	Reeve, Mon. of *Oliva*, pl. XX, fig. 50.	Ditto.
17. *Clavatula fulminata*, Kiener	Reeve, Mon. of *Pleurotoma*, pl. V, fig. 37.	Ditto.
18. *Conus literatus*, Linné	Reeve, Mon. of *Conus*, pl. XXXIII, fig. 183.	Ditto.
19. „ *malaccanus*, Hwas.	Reeve, Mon. of *Conus*, pl. X, fig. 49.	Ditto.

2. *Sub-identical species.*—This group contains, roughly speaking, all those species which are neither exactly identical, nor represent an evolutionary stage of living species, but which are so similar to living species, that there can be no doubt as to their representing their Miocene ancestors.

The relationship in which these species stand to their living descendants is rather a peculiar one; the living species cannot be called a variety of the fossil one, nor is it a new species which has evolved from the former one. As for a variety the features are too different, and for a new species the features are again too similar. The difference may best be characterised as follows: In the Miocene we have a small shell with a delicate ornamentation; in the recent fauna we have exactly the same characters, but the whole is transformed to the coarse, so to speak; the shell has become larger and the ornamentation much stronger. The term *mutatio* might perhaps be applied to this group.

In other instances like that of *Gari protokingi*, spec. nov., *Gari kingi*, Noetl., *Gari deuterokingi*, spec. nov., *Gari caerulescens*, Reeve, which represent a perfect line of evolution from the zone of *Parallelipipedum prototortuosum* to the present times, it is certain that by a gradual change a new species has evolved from an older one. There is no doubt as to the difference of *Gari protokingi*

and *Gari caerulescens*, yet both species are intimately connected by the intermediate species of *Gari kingi* and *Gari deuterokingi*.

It is unfortunate that no definite rules can be given as to the delimitation of both sub-groups, because too much is left to the personal opinion. Two authors might perfectly disagree as to what is to be considered a new species, or a mutatio, or even whether two species are identical or not. The line here taken expresses of course my personal view, and others may differ from it, yet I think that the mutatios greatly exceed the new species among this group.

Pelecypoda and Gastropoda contribute almost evenly towards its composition, there being 10 of the former and nine of the latter.

List of sub-identical species.[1]

Name of species.	Name of next living relative.	Reference.
1. *Lima protosquamosa*, spec. nov.	*Lima squamosa*, Lmk.	Reeve, Mon. of *Lima*, pl. II, fig. 10.
2. *Cucullaea protoconamerata*, spec. nov.	*Cucullaea concamerata*, Linné	Reeve, Mon. of *Cucullaea*, pl. I, fig. 1.
3. *Nucula alcocki*, Noetl.	*Nucula cumingii*, Hinds.	Reeve, Mon. of *Nucula*, pl. I, fig. 5.
4. *Cardita protovariegata*, spec. nov.	*Cardita variegata*, Brug.	Reeve, Mon. of *Cardita*, pl. I, fig. 3.
5. *Dione protophilippinarum*, spec. nov.	*Dione philippinarum*, Han.	Reeve, Mon. of *Cytherea*, pl. X, fig. 47.
6. *Tapes protolirata*, spec. nov.	*Tapes lirata*, Phil. spec.	Reeve, Mon. of *Tapes*, pl. V, fig. 20.
7. *Gari protokingi*, spec. nov.	*Gari caerulescens*, Lmk.	Reeve, Mon. of *Psammobia*, pl. VIII, fig. 60.
8. *Gari kingi*, Noetl.		
9. „ *deuterokingi*, spec. nov.		
10. *Corbula socialis*, K. Martin.	*Corbula crassa*, Hinds.	Reeve, Mon. of *Corbula*, pl. I, fig. 8.
11. *Torinia protodorsuosa*, spec. nov.	*Solarium dorsuosum*, Sow.	......
12. *Natica obscura*, Sow.	*Natica lineata*, Lmk.	Reeve, Mon. of *Natica*, pl. VII, fig. 24.
13. *Eburna protozeylanica*, spec. nov.	*Eburna zeylanica*, Lmk.	Reeve, Mon. of *Eburna*, pl. I, fig. 8.
14. *Fasciolaria nodulosa*, Sow.	*Fasciolaria filamentosa*, Martini	Reeve, Mon. of *Fasciolaria*, pl. II, fig. 4.
15. *Pyrula pseudobucephala*, spec. nov.	*Pyrula bucephala*, Lmk.	Reeve, Mon. of *Pyrula*, pl. VII, fig. 24.
16. *Strioterebrum protomyuros*, spec. nov.	*Terebra myuros*, Lmk.	Reeve, Mon. of *Terebra*, pl. VIII. fig. 31.
17. *Terebrum protoduplicatum*, spec. nov.	*Terebra duplicata*, Linné spec.	Reeve, Mon. of *Terebra*, pl. I, fig. 3.
18. *Drillia protointerrupta*, spec. nov.	*Drillia interrupta*, Lmk.	Reeve, Mon. of *Pleurotoma*, pl. VII, fig. 1.
19. *Drillia protocincta*, spec. nov.	*Drillia cincta*, Lmk.	Reeve, Mon. of *Pleurotoma*, pl. XII, fig. 99.

[1] All these species have been compared with specimens from the Indian Museum.

3. *Evolutionary species.*—This small, but interesting group includes such species which with certainty were recognised to represent permanent juvenile stages of living species. So far it seems that they all exhibit about the same stage of evolution, not that one species represents a far more advanced stage than the other. This question is, however, not finally settled, the total number of species belonging to this group being not more than 8.

List of evolutionary species.

Name of species.	Name of next living relative.	Reference.
1. *Pecten protosenatorius*, spec. nov.	*Pecten senatorius*, Gmel. .	Reeve, Mon. of *Pecten*, pl. XXXIV, fig. 159.
2. *Arca burnesi*, d'Arch. and Haime. 3. ,, *theobaldi*, spec. nov.	*Arca granosa*, Linné. . .	Reeve, Mon. of *Arca*, pl. III, fig.15.
4. ,, *metabistrigata*, spec. nov.	*Arca bistrigata*, Dunker .	......
5. *Cardium protosubrugosum*, spec. nov.	*Cardium subrugosum*, Sow. .	Reeve, Mon. of *Cardium*, pl. XI, fig. 55.
6. *Corbula prototruncata*, spec. nov.	*Corbula truncata*, Sow. .	......
7. *Ranella prototubercularis*, spec. nov.	*Ranella tubercularis*, Lmk. .	......
8. *Clavatula protonodifera*, spec. nov.	*Pleurotoma nodifera*, Lmk. .	Reeve, Mon. of *Pleurotma*, pl. IV, fig. 25.

Meagre as this list is, it seems certain that the number of Pelecypoda is far greater than that of the Gastropoda, the proportion being 75 : 25. If we recollect that a similar disproportion existed between the Pelecypoda and Gastropoda of the Pacific types, where the ratio was 75 : 18, it is perhaps not too rash to suppose that the Pelecypoda of the Miocene formation were probably in a stage of transformation, while the Gastropoda represented a more stabile element.

4. *Species not classified.*—This represents a small number of species, *viz.* :—

1. *Cyrena kodoungensis*, spec. nov.
2. *Xenophora birmanica*, spec. nov.
3. *Natica callosa*, Sow.
4. ,, *gracilior*, spec. nov.

which most probably have living relatives among the fauna of the Indian Ocean, but which owing to the indifference of their features, caused by the state of preservation, could not be brought in relation with any given species, but appeared to be related to quite a number of them. Better preserved specimens will perhaps in future allow for their classification.

(C) *Summary of Palæontological Considerations.*

The following table will give in a convenient arrangement the chief results of the foregoing remarks, at least as they can be expressed by figures; the left-hand part contains the absolute number of species contained in each group, and the first column contains the total of Pelecypoda and Gastropoda, while in the second and third one, each class is considered separately. In adding up the figures it will be seen that in the first and second columns the total number of 169 and 82 exceeds that of actual number, *viz.*, 167 and 80 by two. This is accounted for by the two species *Lucina neasquamosa* and *Lucina pagana* being counted twice, once among the Gallic, and the second time among the Pacific types.

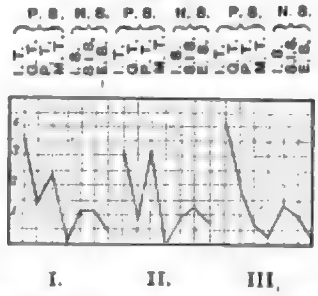
The right-hand part contains the percentage each of the six groups contributes towards the composition of the fauna. In the first column the total of Pelecypoda and Gastropoda is given, in the second and third each class separately.

		Absolute Numbers.			In per cents.		
		Total.	Pelecypoda.	Gastropoda.	Total of Fauna.	Pelecypoda.	Gastropoda.
Palæogene species.	Species of which no relatives, either living or fossil, could be traced (*Indigenous types*)	62	25	37	36·2%	31·25%	42·35%
	Species of which the nearest relatives occur in the Eocene of Paris (*Gallic types*)	23	7	16	13·8%	8·75%	18·40%
	Species of which the nearest relatives live at present in China, Japan, Philippines, Australia (*Pacific types*)	31	25	6	18·6%	31·25%	6·90%
	Species of which the nearest relatives live at present in the Mediterranean (*Mediterranean types*)	2	...	2	1·2%	...	2·30%
	Species not classified	1	1	...	0·6%	1·25%	...
Neogene species.	Species which are *identical* with species living in the Indian Ocean	19	7	12	11·4%	8·75%	13·80%
	Species which are *sub-identical* with species living in the Indian Ocean	19	10	9	11·4%	12·50%	10·35%
	Species representing a permanent *evolutionary* stage of species living in the Indian Ocean	8	6	2	4·8%	7·50%	2·30%
	Species not classified	4	1	3	2·4%	1·25%	3·45%

Though these figures are in themselves instructive enough, their value will be better realized from the following diagram in which the per cents. have been entered from the bottom to the top, while the groups are represented from left to right.

The first curve represents that of the total of Pelecypoda and Gastropoda (I), the second and third one that of the Pelecypoda (II), and Gastropoda (III) separately.

Fig. 1.



The "curve of composition" as it may be called is very instructive. We see at the first glance the great difference that exists in the composition of the Gastropoda and Pelecypoda by the different shape of the curve; we also notice that this difference is solely caused by the composition of the palæogene species, represented by the left part of the curve, while the right part which represents the neogene species, is very similar in both classes, thus indicating a very similar composition of the neogene class of Pelecypoda and Gastropoda.

If we compare the curves of the Pelecypoda and Gastropoda, with that expressed by the total of both classes, the striking similarity between this curve and that of the Pelecypoda is evident. The Pelecypoda have therefore impressed their stamp on the curve, notwithstanding that Pelecypoda and Gastropoda are represented by almost equal numbers (80 and 87), the latter being even slightly in excess.

We have now to inquire what reason caused this difference. As already stated the composition of the palæogene species accounts for it, and the reason is clearly visible: it is the small number of Gallic and the large number of Pacific types. The Pelecypoda having thus influenced the curve of composition, we must endeavour to ascertain the nature of this influence, which I think can be found in the rapidly changing character of the Pelecypoda, while the Gastropoda represented a more stable element, subject to a far smaller degree of alteration.

This view is fully supported by figures; out of a total of 80 species of Pelecypoda, not more than 7 or 8·75 per cent., or if we add to this the number of mutatios with 7, 14 or 17·5 per cent., can be considered as identical with living species. In a strange contrast stands the large figure of those which are not absolutely identical with living species; this group is composed of the palæogene species, the evolutionary species and the small number of the sub-identical species represented by *Gari protokingi*, *Gari kingi* and *Gari deuterokingi*, aggregating to 66 or 82·5 per cent.

If we examine the Gastropoda we see that 21 species or 24·15 per cent. of the total are identical with living species, while the remainder of 63 species or 72·25 per cent. is represented by the non-identical species.

Yet these figures do not quite reveal the true facts, which are shown, if we take the Pacific and evolutionary species together, as the former can certainly be

considered as a modification of the latter, in being represented by living species, though occurring outside the Indian Ocean, and then compare Pelecypoda and Gastropoda.

The number of Pelecypoda is 31 or 38·75 per cent. while the same group is only represented by 8 Gastropoda or 9·20 per cent. If we compare with those figures the number of species identical with living ones, *viz.*, 14 or 17·5 per cent. of Pelecypoda and 21 species or 24·15 per cent. of Gastropoda, the contrast becomes evident. We can therefore with a great amount of probability assume, that while the Gastropoda remained fairly stable, the Pelecypoda were subject to great changes; a large number died out, a good number migrated into foreign seas, being differently affected and modified during this process, a small number gradually evolved new characters, a still smaller number producing new species, while only a few did not change and persisted in an unaltered state from the Miocene to recent times.

In the next table I have still more summarized the results by adding together the different groups composing the palæogene and neogene species. This table would thus represent those species which would formerly have been summarily called "extinct" and "recent" species, and these figures would have to be used when determining the age of the series by means of Lyell's rule.

The first part of the table contains the actual number of species, the second the per cents., Pelecypoda and Gastropoda being again considered separately.

	ABSOLUTE NUMBER.			IN PER CENTS.		
	Total.	Pelecypoda.	Gastropoda.	Total.	Pelecypoda.	Gastropoda.
Palæogene species	117	56	61	70·4%	70·0%	70·11%
Neogene species	50	24	26	30·0%	30·0%	30·0 %
TOTAL .	167	80	87	...	...	...

These figures give the very interesting result that whatever their composition may be, the total of the palæogene and neogene species is represented in both the Pelecypoda and Gastropoda by the same proportion, *viz.*, 70 per cent : 30 per cent. This harmony of figures seems to prove that whatever cause may have influenced certain groups of either Pelecypoda or Gastropoda, both classes taken as a whole stand in the same relation to the present fauna of the Indian Ocean by containing 30 per cent. of species which are more or less the same, as species inhabiting this region nowadays.

(D) *Vertical Distribution of the Different Groups of Palæogene and Neogene Species.*

In the following tables the vertical distribution of the different groups of fossils has been given, and the results of this investigation are expressed by the last three tables, the first of which gives the absolute number of species, the second the per cents., and the third the number and per cents. of the palæogene and neogene

species, all tables giving the sum of Pelecypoda and Gastropoda, because a division into both classes does not appear to give any new results.

	Name of Species.	Zone of *Cytherea erycina.*	Zone of *Aricia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parall. prototortuosum.*	Zone of *Arca theobaldi.*	Zone of *Anoplotherium birmanicum.*	Zone of *Paracyathus caeruleus.*	Zone of *Cancellaria martiniana.*	Zone of *Dione dubiosa.*	Zone of *Meiocardia metavulgaris.*	Zone of *Mytilus nicobaricus.*	Zone of *Cardita tjidamarensis.*	Zone of *Cyrena crawfurdi.*	Uncertain.
	Indigenous types.														
1	*Ostrea peguensis*, spec. nov.	·	·	·	·	·	·	·	·	·	·	·	·	·	●
2	*Lima griesbachiana*, spec. nov.	·	●	·	·	·	·	·	·	·	·	·	·	·	·
3	*Vulsella lingua-tigris*, spec. nov.	·	·	·	●	·	·	·	·	·	●	●	·	·	·
4	*Modiola buddhaica*, spec. nov.	·	·	·	·	·	·	·	·	·	●	●	·	·	·
5	„ *pseudobuddhaica*, spec. nov.	·	·	·	·	·	·	·	·	·	·	●	·	·	·
6	*Arca oldhamiana*, spec. nov.	·	·	●	·	·	·	·	·	·	·	·	·	·	·
7	„ *yawensis*, spec. nov.	·	·	·	●	·	·	·	·	·	·	·	·	·	·
8	„ *myoënsis*, spec. nov.	·	·	·	·	●	·	·	·	·	·	·	·	·	·
9	„ *nannodes*, K. Martin.	·	·	·	·	●	·	·	·	·	·	·	·	·	·
10	„ *peethensis*, d'Arch. and Haime.	·	·	●	●	·	·	·	·	·	·	·	·	·	·
11	*Nucula phayreiana*, spec. nov.	·	·	·	●	·	·	·	·	·	·	·	·	·	·
12	*Leda birmanica*, spec. nov.	·	·	·	·	·	·	·	·	·	●	·	·	·	·
13	„ *virgo*, K. Martin.	·	·	·	·	●	·	·	·	·	·	·	·	·	·
14	„ *avaënsis*, spec nov.	·	·	·	●	·	·	·	·	·	·	·	·	·	·
15	*Cardita viquesneli*, d'Arch. and Haime.	·	●	·	●	·	·	·	·	·	●	●	·	·	·
16	„ *planicosta*, spec. nov.	·	●	●	·	·	·	·	·	·	·	●	·	·	·
17	*Lucina d' archiaciana*, spec. nov.	·	·	·	·	·	·	·	·	●	·	·	·	·	·
18	*Cardium minbuense*, spec. nov.	·	●	·	●	·	·	·	·	·	·	●	·	·	·
19	*Petricola incerta*, spec. nov.	·	·	●	·	·	·	·	·	·	·	·	·	·	·
20	*Cytherea yomaënsis*, spec. nov.	·	·	●	·	·	·	·	·	·	·	·	·	·	·
21	*Dione arrakanensis*, spec. nov.	·	·	·	●	·	·	·	·	·	·	·	·	·	·
22	„ *amygdaloides*, spec. nov.	·	●	●	●	●	·	●	·	·	·	●	·	·	·
23	„ *dubiosa*, spec. nov.	·	·	·	·	·	·	·	●	●	·	·	·	·	·
24	*Hiatula textilis*, spec. nov.	·	·	·	●	·	·	·	·	·	·	·	·	·	·
25	*Corbula rugosa*, Sow.	·	·	·	·	·	·	·	·	·	●	●	·	·	·
26	*Dentalium battigeri*, spec. nov.	·	·		·	●	·	·	·	·	·	·	·	·	·
27	*Calliostoma blanfordi*, Noetling.	·	·	·	·	·	·	●	●	·	●	●	·	·	·

	Name of Species.	Zone of *Cytherea erycina.*	Zone of *Aricia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parall. prototortuosum.*	Zone of *Arca theobaldi.*	Zone of *Anoplotherium birmanicum.*	Zone of *Paracyathus caeruleus.*	Zone of *Cancellaria martiniana.*	Zone of *Dione dubiosa.*	Zone of *Meiocardia metavulgaris.*	Zone of *Mytilus nicobaricus.*	Zone of *Cardita tjidamarensis.*	Zone of *Cyrena crawfurdi.*	Uncertain.
	Indigenous types—*contd.*														
28	***Calliostoma kaenianum***, spec. nov.	.	.	.	.	●	.	.	.	.	.	.	.	.	.
29	***Basilissa loriolianа***, spec. nov.	.	.	.	.	●	.	.	.	.	●	●	.	.	.
30	***Solarium coniforme***, spec. nov.	.	●	.	.	.	.	.	.	.	.	.	.	.	.
31	***Torinia buddha***, Noetling.	.	.	.	.	.	.	●	●	.	.	.	.	.	.
32	***Scalaria leptopleurata***, spec. nov.	.	.	.	.	.	.	.	.	●	.	.	.	.	.
33	„ ***irregularis***, Noetling.	.	.	.	.	.	.	.	●	.	.	.	.	.	.
34	***Turritella simplex***, Jenkins.	.	.	.	●	●	.	.	.	.	.	●	.	.	.
35	„ ***affiniformis***, spec. nov.	.	.	.	.	.	.	●	●	.	.	.	.	.	.
36	***Cypraea granti***, Sowerby.	.	.	.	.	.	.	●	●	.	●	●	.	.	.
37	***Aricia humerosa***, Sow., spec.	.	●	.	.	.	.	.	.	.	.	.	.	.	.
38	***Trivia smithi***, K. Martin.	.	.	.	.	.	.	●	.	.	.	.	.	.	.
39	***Cassis d'archiaci***, Noetling.	.	.	.	.	.	.	.	●	.	.	.	.	.	.
40	***Galeodea monilifera***, spec. nov.	.	.	.	.	●	.	.	.	.	●	●	.	.	.
41	***Oniscidia minbuensis***, Noetling.	.	.	.	.	.	.	.	●	.	.	.	.	.	.
42	***Ficula theobaldi***, Noetling.	.	.	.	.	.	.	●	●	.	●	●	.	.	.
43	***Triton pardalis***, Noetling.	.	.	.	.	●	.	●	●	.	.	.	.	.	.
44	***Persona gautama***, spec. nov.	.	.	.	.	●	.	.	.	.	.	.	.	.	.
45	***Fusus verbeeki***, K. Martin.	.	●	.	.	.	.	.	.	.	.	.	.	.	.
46	***Murex arrakanensis***, spec. nov.	.	.	.	.	.	.	.	●	.	.	.	.	.	.
47	„ (?) ***tchihatcheffi***, d'Arch. and Haime.	.	.	.	.	.	.	●	.	.	.	.	.	.	.
48	***Voluta vingens***, spec. nov.	.	.	.	.	.	.	.	●	.	.	.	.	.	.
49	***Cancellaria inornata***, spec. nov.	.	.	.	.	●	.	.	.	.	.	.	.	.	.
50	„ ***martiniana***, spec. nov.	.	.	.	.	.	.	●	●	.	.	.	.	.	.
51	***Strioterebrum unicinctum***, spec. nov.	.	.	.	.	●	.	.	.	.	.	.	.	.	.
52	„ ***bicinctum***, spec. nov.	.	.	.	.	●	.	.	.	.	.	.	.	.	.
53	***Terebrum smithi***, K. Martin.	.	.	.	.	.	.	.	●	.	.	.	.	.	.
54	***Pleurotoma karenaica***, spec. nov.	.	.	.	.	●	.	.	.	.	.	.	.	.	.
55	***Surcula feddeni***, Noetling.	.	.	.	.	●	.	●	●	.	.	.	.	.	.
56	***Genota irravadica***, Noetling.	.	.	.	.	.	.		●	.	.	.	.	.	?
57	***Clavatula munga***, spec. nov.	.	.	.	●	.	.	.	.	.	.	.	.	.	.

	Name of Species.	Zone of *Cytherea erycina.*	Zone of *Aricia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parall. prototortuosum.*	Zone of *Arca theobaldi.*	Zone of *Anoplotherium birmanicum.*	Zone of *Paracyathus caeruleus.*	Zone of *Cancellaria martiniana.*	Zone of *Dione dubiosa.*	Zone of *Meiocardia metavulgaris.*	Zone of *Mytilus nicobaricus.*	Zone of *Cardita tjidamarensis.*	Zone of *Cyrena crawfurdi.*	Uncertain.
	Indigenous types—*concld.*														
58	*Drillia yenanensis*, Noetling.							●							
59	„ *promensis*, spec. nov.					●									
60	*Conus yulsianus*, spec. nov.		●		●										
61	„ *galensis*, spec. nov.							●							
62	*Ringicula turrita*, K. Martin.				●										
	2. Gallic types.														
1	*Ostrea promensis*, spec. nov.														●
2	„ *papyracea*, spec. nov.				●	●									
3	*Pecten kokenianus*, spec. nov.	●	●	●	●	●	●								
4	„ *irravadicus*, spec. nov.								●		●	●			
5	*Lucina pagana*, spec. nov.				●			●							
6	„ *neaequamosa*, spec. nov.				●										
7	*Tellina grimesi*, spec. nov.	●	●	●	●	●					●	●			
8	*Solarium nitens*, spec. nov.			●											
9	*Scalaria spathica*, spec. nov.								●						
10	*Turritella acuticarinata*, Dunker.				●	●									
11	„ *leiopleurata*, spec. nov.				●										
12	„ *lydekkeri*, spec. nov.				●										
13	„ *angulata*, Sowerby.														●
14	*Vermetus javanus*, K. Martin.	●	●		●										
15	*Fossarus krausei*, spec. nov.					●									
16	*Triton neastriatulus*, spec. nov.							●							
17	„ *neacolubrinus*, spec. nov.					●									
18	*Fusus seminudus*, spec. nov.							●	●						
19	*Volvaria birmanica*, Noetling.								●						
20	*Voluta dentata*, Sowerby.							●	●						
21	*Cancellaria neavolutella*, spec. nov.					●									
22	„ *davidsoni*, d'Archiac.							●	●						
23	*Conus avaënsis*, spec. nov.	●	●	●	●	●					●	●			

	Name of Species.	Zone of *Cytherea erycina.*	Zone of *Ariria humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parall. prototortuosum.*	Zone of *Arca theobaldi.*	Zone of *Anoplotherium birmanicum.*	Zone of *Paracyathus caeruleus.*	Zone of *Cancellaria martiniana.*	Zone of *Dione dubiosa.*	Zone of *Meiocardia metavulgaris.*	Zone of *Mytilus nicobaricus.*	Zone of *Cardita tjidamarensis.*	Zone of *Cyrena crawfurdi.*	Uncertain.
	3. Pacific types.														
1	*Avicula suessiana*, spec. nov.	·	·	·	·	·	·	·	·	·	●	·	·	·	·
2	*Arca thayetensis*, spec. nov.	·	·	·	·	·	·	·	·	·	·	·	·	·	●
3	„ *bataviana*, K. Martin.	·	·	●	·	●	·	·	·	·	·	·	·	·	·
4	*Parallelipipedum prototortuosum*, spec. nov.	·	·	·	●	·	·	·	·	·	·	·	·	·	·
5	*Cardita scabrosa*, spec. nov.	·	·	·	·	·	·	·	·	·	●	·	·	·	·
6	„ *tjidamarensis*, K. Martin.	·	·	·	·	·	·	·	·	·	●	·	●	·	·
7	*Crassatella dieneri*, spec. nov.	·	·	·	·	·	·	·	·	·	●	●	·	·	·
8	*Lucina neasquamosa*, spec. nov.	·	·	·	●	·	·	·	·	·	·	·	·	·	·
9	„ *pagana*, spec. nov.	·	·	·	●	·	·	●	·	·	·	·	·	·	·
10	*Cyrena crawfurdi*, Noetling.	·	·	·	·	·	·	·	·	·	·	·	·	●	·
11	„ *petrolei*, Noetling.	·	·	·	·	·	·	·	·	·	·	·	·	●	·
12	*Meiocardia protovulgaris*, spec. nov.	·	·	●	●	·	·	·	·	·	·	·	·	·	·
13	„ *metavulgaris*, spec. nov.	·	·	·		·	·	·	·	·	●	●	·	·	·
14	*Venus protoflexuosa*, spec. nov.	·	·	●	·	·	·	●	·	·	·	·	·	·	·
15	*Dione protolilacina*, spec. nov.	●	·	●	●	●	·	·	·	·	●	●	·	·	·
16	*Dosinia protojuvenilis*, spec. nov.	●	●	·	●	·	·	·	·	·	·	·	·	·	·
17	*Tellina protostriatula*, spec. nov.	·	·	·	●	●	·	·	·	·	·	·	·	·	·
18	„ *protocandida*, spec. nov.	·	·	·	●	·	·	·	·	·	·	·	·	·	·
19	„ *indifferens*, spec. nov.	·	·	·	●	·	·	·	·	·	·	·	·	·	·
20	„ *hilli*, Noetling.	·	●	●	●	●	·	●	●	·	·	·	·	·	·
21	„ *pseudohilli*, spec. nov.	·	·	·	●	·	·	·	·	·	·	·	·	·	·
22	*Gari natensis*, spec. nov.	·	·	·	●	·	·	·	·	·	·	·	·	·	·
23	*Solecurtus exsulcatus*, spec. nov.	·	·	·	·	·	·	·	·	·	·	·	·	·	●
24	*Mactra protoreevesii*, spec. nov.	·	·	●	●	·	·	·	·	·	·	·	·	·	·
25	*Pholas blanfordianus*, spec. nov.	·	·	●	·	·	·	·	·	·	·	·	·	·	·
26	*Turcica protomonilifera*, spec. nov.	·	·	·	·	●	·	·	·	·	●	·	·	·	·
27	*Scalaria birmanica*, spec. nov.	·	·	·	●	·	·	·	●	·	·	·	·	·	·
28	*Calyptraea rugosa*, Noetling.	·	●	●	·	●	·	●	●	·	·	●	·	·	·
29	*Semicassis protojaponica*, spec. nov.	·	·	·	·	·	·	·	●	·	·	·	·	·	·
30	*Conus protofurvus*, spec. nov.	·	·	·	●	·	·	●	·	·	·	·	·	·	·
31	„ *hanza*, spec. nov.	·	·	·	●	·	·	·	·	·	·	·	·	·	·

Name of Species.	Zone of *Cytherea erycina.*	Zone of *Aricia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parall. protortuosum.*	Zone of *Arca theobaldi.*	Zone of *Anoplotherium birmanicum.*	Zone of *Paracyathus caeruleus.*	Zone of *Cancellaria martiniana.*	Zone of *Dione dubiosa.*	Zone of *Meiocardia metavulgaris.*	Zone of *Mytilus nicobaricus.*	Zone of *Cardita jaidamarensis.*	Zone of *Cyrena crawfurdi.*	Uncertain.
4. Mediterranean types.														
1 *Discohelix minuta*, Noetling.	.	.	.	.	.	.	.	•	.	.	.	.	.	.
2 *Cancellaria pseudocancellata*, spec. nov.	.	.	.	.	.	.	•	.	.	.	.	.	.	.
5. Species not classified.														
1 *Ostrea promensis*, spec. nov. *var.*	.	.	.	.	.	.	.	.	.	.	.	.	.	•
6. Identical Species.														
1 *Mytilus nicobaricus*, Chemnitz.	.	.	.	.	.	.	.	.	.	.	•	.	.	.
2 *Arca bistrigata*, Dunker.	.	.	.	.	•	•	•	•	.	•	•	.	.	.
3 *Crassatella rostrata*, Lmk.	.	•	.	.	.	.	.	.	.	.	.	.	.	.
4 *Venus granosa*, Sowerby.	.	.	.	.	.	.	.	.	.	.	.	.	.	•
5 *Cytherea erycina*, Favanne.	•	.	•	•	.	.	.	.	.	.	.	.	.	.
6 *Tellina foliacea*, Reeve.	.	•	•	•	•	.	.	.	.	.	.	.	.	.
7 *Pholas orientalis*, Gmelin.	.	.	•	.	.	.	.	.	.	.	.	.	.	.
8 *Dentalium junghuhni*, K. Martin.	.	.	.	•	.	.	.	.	.	.	•	.	.	.
9 *Solarium maximum*, Philippi.	.	.	.	•	•	.	•	•	.	•	•	.	.	.
10 *Sigaretus neritoideus*, Linné.	•	.	.	•	.	.	•	.	.	.	•	.	.	.
11 *Rimella crispata*, Sowerby.	.	.	.	.	•	.	.	.	.	.	.	.	.	•
12 *Ranella elegans*, Beck.	•	•	.	•	.	.	.	.	.	.	.	.	.	.
13 *Pyrula pugilina*, Born. spec.	•	.	.	.	.	.	.	.	.	.	.	.	.	.
14 „ *bucephala*, Lmk. spec.	.	.	.	.	.	.	.	.	.	.	•	.	.	.
15 *Marginella scripta*, Reeve.	.	.	.	.	•	.	.	.	.	.	.	.	.	.
16 *Oliva rufula*, Duclos.	.	•	.	•	•	.	•	•	.	.	•	.	.	.
17 *Clavatula fulminata*, Kiener.	.	.	.	.	.	.	.	.	.	.	•	.	.	.
18 *Conus literatus*, Linné.	.	•	.	.	.	.	.	.	.	.	.	.	.	.
19 „ *malaccanus*, Hwas.	.	.	.	.	.	.	•	•	.	.	.	.	.	.
7. Sub-identical Species.														
1 *Lima protosquamosa*, spec. nov.	.	.	.	.	.	.	.	.	.	.	•	.	.	.
2 *Cucullaea protoconcamerata*, spec. nov.	.	.	.	.	.	.	.	.	.	.	.	.	.	•
3 *Nucula alcocki*, Noetling.	.	.	.	.	•	.	•	•	.	•	.	.	.	.
4 *Cardita protovariegata*, spec. nov.	•	.	.	•	.	.	.	.	.	.	.	.	.	.

	Name of Species.	Zone of *Cytherea erycina.*	Zone of *Aricia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parall. prototortuosum.*	Zone of *Arca theobaldi.*	Zone of *Anoplotherium birmanicum.*	Zone of *Paracyathus caeruleus.*	Zone of *Cancellaria martiniana.*	Zone of *Dione dubiosa.*	Zone of *Meiocardia metavulgaris.*	Zone of *Mytilus nicobaricus.*	Zone of *Cardita tjidamarensis.*	Zone of *Cyrena crawfurdi.*	Uncertain.
	7. Sub-identical species.														
5	*Dione protophilippinarum*, spec. nov.	●	●	●	●	●	●	●	●		●	●			
6	*Tapes protolirata*, spec. nov.														●
7	*Gari protokingi*, spec. nov.				●	●									
8	„ *kingi*, Noetling.							●	●		●				
9	„ *deuterokingi*, spec. nov.											●			
10	*Corbula socialis*, K. Martin.			●	●	●									
11	*Torinia protodorsuosa*, spec. nov.					●			●						
12	*Natica obscura*, Sowerby.	●	●	●	●	●		●	●						
13	*Eburna protozeylanica*, spec. nov.	●				●									
14	*Fasciolaria nodulosa*, Sowerby.							●	●						
15	*Pyrula pseudobucephala*, spec. nov.											●			
16	*Strioterebrum protomyuros*, spec. nov.					●									
17	*Terebrum protoduplicatum*, spec. nov.					●									
18	*Drillia protointerrupta*, spec. nov.					●			●						
19	„ *protocincta*, spec. nov.					●									
	8. Evolutionary species.														
1	*Pecten protosenatorius*, spec. nov.														●
2	*Arca burnesi*, d'Arch. and Haime.				●										
3	„ *theobaldi*, spec. nov.					●									
4	„ *metabistrigata*, spec. nov.					●									
5	*Cardium protosubrugosum*, spec. nov.		●		●										
6	*Corbula prototruncata*, spec. nov.					●			●	●	●				
7	*Ranella prototubercularis*, spec. nov.				●	●		●	●						
8	*Clavatula protonodifera*, spec. nov.								●			●			
	9. Species not classified.														
1	*Cyrena kodoungensis*, spec. nov.													●	
2	*Xenophora birmanica*, spec. nov.		●												
3	*Natica callosa*, Sowerby.	●	●		●	●		●	●						
4	„ *gracilior*, spec. nov.				●										

Table showing the vertical distribution of the different groups of Pelecypoda and Gastropoda.

ACTUAL NUMBERS.

		Zone of *Cytherea erycina*, Fav.	Zone of *Aricia humerosa*, Sow. spec.	Zone of *Pholas orientalis*, Gml.	Zone of *Parallelipipedum prototortuosum*, spec. nov.	Zone of *Arca theobaldi*, spec. nov.	Zone of *Paracyathus caeruleus*, Dunc.	Zone of *Cancellaria martiniana*, spec. nov.	Zone of *Miocardia metavulgaris*, spec. nov.	Zone of *Mytilus nicobaricus*, Chemn.
PALAEOGENE SPECIES.	Species of which no relatives, either living or fossil, could be traced (*Indigenous types*).	...	9	6	14	17	13	16	10	15
	Species of which the nearest relatives occur in the Eocene of Paris (*Gallic types*).	4	4	4	10	8	6	6	3	3
	Species of which the nearest relatives live at present in China, Japan, Philippines, Australia (*Pacific types*).	2	3	8	16	6	4	4	7	4
	Species of which the nearest relatives live at present in the Mediterranean (*Mediterranean types*).	...	...	...	...	...	1	1	...	...
NEOGENE SPECIES.	Species which are *identical* with species living in the Indian Ocean.	4	5	3	7	5	5	4	2	8
	Species which are *sub-identical* with species living in the Indian Ocean.	4	2	3	5	11	5	7	3	5
	Species representing a permanent *evolutionary* stage of species living in the Indian Ocean.	...	1	...	3	4	1	3	...	1
	Species not classified	1	2	...	2	1	1	1	...	...
	TOTAL .	15	26	24	57	52	36	42	25	36

Table showing the vertical distribution of the different groups of Pelecypoda and Gastropoda.

IN PER CENTS.

		Zone of *Cytherea erycina*, Fav.	Zone of *Aricia humerosa*, Sow.	Zone of *Pholas orientalis*, Gml.	Zone of *Parallelipipedum prototortuosum*, spec. nov.	Zone of *Arca theobaldi*, spec. nov.	Zone of *Paracyathus caeruleus*, Dunc.	Zone of *Cancellaria martiniana*, spec. nov.	Zone of *Meiocardia metavulgaris*, spec. nov.	Zone of *Mytilus nicobaricus*, Chemn.
Palaeogene Species.	Species of which no relatives, either living or fossil, could be traced (*Indigenous types*).	...	34·56	25·00	24·50	31·96	36·4	38·08	40·00	42·0
	Species of which the nearest relatives occur in the Eocene of Paris (*Gallic types*).	26·66	15·36	16·66	17·50	17·04	16·8	14·28	12·00	18·4
	Species of which the nearest relatives live at present in China, Japan, Philippines, Australia (*Pacific types*).	13·33	11·52	33·33	28·00	11·28	11·2	9·52	28·00	11·2
	Species of which the nearest relatives live at present in the Mediterranean (*Mediterranean types*).	...	...	...	...	...	2·8	2·38	...	...
Neogene Species.	Species which are *identical* with species living in the Indian Ocean.	26·66	19·20	12·50	12·25	9·40	14·0	9·52	8·00	22·4
	Species which are *sub-identical* with species living in the Indian Ocean.	26·66	7·68	12·50	8·75	20·68	14·0	16·66	12·00	14·8
	Species representing a permanent *evolutionary* stage of species living in the Indian Ocean.	...	3·84	...	5·25	7·52	2·8	7·14	...	2·8
	Species not classified.	6·66	7·68	...	3·50	1·88	2·8	2·38	...	...

In the summary tables the zones of *Anoplotherium birmanicum, Dione dubiosa, Cardita tjidamarensis, Cyrena crawfurdi* and those species, the horizon of which is unknown, have been omitted for obvious reasons. In the four first-named horizons the number of Pelecypoda and Gastropoda is too small to be of any practical value, and those species of which the horizon is not known, of course cannot come into consideration, though some of the most interesting species come under this group. For the same reason the group of species not classified has been omitted among the palæogene species.

Though the first table gives the actual figures, the information they contain is not made so evident as in the following table where the per cents. are given.

By the help of these figures some exceedingly interesting results are obtained. The lowest fossiliferous horizon, that of *Cytherea erycina*, appears to be very abnormal, if those fossils that have been examined by me really represent its fauna; their number being however very small, aggregating to 15 only, not including species which have only generically been determined. It is therefore quite probable that if more extensive collections will be made, that is to say, if the fauna is more completely known, the figures will be different. It seems rather strange that this fossiliferous horizon should not contain any indigenous types at all, a group which in all the other horizons is represented by one-quarter to over one-third of the total fauna. This fact alone is sufficient to make the figures appear rather doubtful, and it is the more emphasized by the neogene being greatly in excess of the palæogene species; the percentage is 59·98°/₀ of the former and 39·99°/₀ of the latter or 60°/₀ and 40°/₀ in round figures, while in all other horizons the proportion is 40·30°/₀ of neogene and 60·70°/₀ of palæogene species. But the figures may not be quite so wrong after all, a view which finds some support in the composition of the fauna of the zone of *Meiocardia metavulgaris*. Having collected the specimens myself, I can confidently say that I got as exhaustive a collection as could be made; yet the fauna of this horizon, which is one of the youngest known, contains the largest percentage of palæogene species, the proportion of palæogene to neogene species being 80°/₀ to 20°/₀. In this instance the small number of species cannot account for this anomaly, because the zones of *Aricia humerosa* and *Pholas orientalis* from which the same number of species have been described, exhibit a perfectly different proportion of palæogene and neogene species, which in both instances approaches closely the average one, though both have, as we see from the diagram on page 78, a very different curve of variation.

The probability, that independent of their vertical position, certain horizons contain a peculiar fauna, the character of which is demonstrated by an anomalous composition, cannot be denied, and has to some extent been forestalled by the remarkable short vertical range most of the species have. This feature requires, however, further examination.

If we, therefore, exclude the horizon of *Cytherea erycina*, there remain eight zones, the analysis of the fauna of which is of great interest.

The group of *indigenous* types varies considerably as it ranges from 24·50°/₀ in the zone of *Parallelipipedum prototortuosum* to 42·0°/₀ in the zone of *Mytilus*

nicobaricus, yet it is quite certain that if the former is not one of the oldest horizons known, it is certainly much older than the latter. The zone of ***Pholas orientalis***, which, though its exact position is not known, is probably closely related to the zone of ***Aricia humerosa*** (see before, page 19) exhibits almost the same percentage of indigenous species, while the zone of ***Meiocardia metavulgaris*** containing 40°/₀ of indigenous species stands in a similar relation to that of ***Mytilus nicobaricus***. The other horizons call for no special remark, the percentage being very close to the average.

The group of ***Gallic*** types shows in general a very small fluctuation, but exceeds in all cases the average percentage, except in the zones of ***Meiocardia metavulgaris*** and ***Mytilus nicobaricus*** where it falls, particularly in the last instance, considerably below the average.

The horizons from upper and lower Burma, if considered together, show a feature of peculiar interest, which makes it particularly regrettable that the sequence in lower Burma is not known with sufficient correctness.

It appears that in upper Burma the percentage of Gallic types decreases from the older to the younger beds, as will be seen from the following figures, in descending order :—

Zone of *Mytilus nicobaricus*	. 8·4°/₀
Zone of *Meiocardia metavulgaris*	. 12·00°/₀
Zone of *Cancellaria martiniana*	. 14·28°/₀
Zone of *Paracyathus caeruleus*	. 16·8°/₀

On the other hand, if we examine the same figures in the order of sequence as adopted, it appears that the percentage increases from the lower to the upper horizons. I am unable to account for this anomaly unless it be that the position attributed to the Kama clay by Mr. Theobald (see page 18) is erroneous, and that the Kama clay instead of being at the top of the section is really at the bottom. It is useless to speculate any further on this problem which will only be solved by actual observation.

The group of ***Pacific*** types exhibits apparently the greatest fluctuations, and its range is larger than any of the groups here distinguished, as it rises as high up as 33·33°/₀ in the zone of ***Pholas orientalis***, while it sinks to 9·52°/₀ in the zone of ***Cancellaria martiniana***. This state may be fairly anticipated from what has been said above about this group. It is chiefly composed of Pelecypoda (80°/₀), and as this class is apparently in a very unstable state it can be expected that in the different horizons it is represented by a varying number of species.

The small group of ***Mediterranean*** types which occurs only in two horizons, calls for no further remark.

If we now summarize these results, which has been done in table on page 79, we see that notwithstanding the considerable difference exhibited by the different groups in the above nine horizons, the total of the palæogene species exhibits a comparatively small range of variation in five horizons, where it fluctuates between 64·26°/₀ and 74·88°/₀; the zones of ***Aricia humerosa*** and ***Mytilus nicobaricus*** have a rather low percentage with 61·44°/₀ and 61·6°/₀ respectively, while the zone of ***Meiocardia metavulgaris*** has an abnormally high percentage with 80°/₀.

If we now turn to the neogene species, we see that the first group, the

identical species, exhibits great fluctuations; in the zone of ***Mytilus nicobaricus*** it is highest with 22·4°/$_0$ and in the zone of ***Meiocardia metavulgaris***, which is only 200 feet lower, it reaches with 8·00°/$_0$ its minimum and rises again in the still older zone of ***Paracyathus caeruleus*** to 14·0°/$_0$.

The group of sub-identical species is subject to the same fluctuations, but it appears that a sort of compensating influence makes itself evident in such a way, that in whatever horizon the number of identical species is small the number of sub-identical species is high and *vice versâ*. The sum of both groups is therefore almost the same in each horizon or at least subject to a much smaller range of fluctuation than noticed in any of the other groups, as can be seen from the following figures:—

Zone of *Aricia humerosa* . . .	26·88°/$_0$
Zone of *Pholas orientalis* . . .	25·00°/$_0$
Zone of *Parallelipipedum prototortuosum* .	21·90°/$_0$
Zone of *Arca theobaldi*	30·08°/$_0$
Zone of *Paracyathus caeruleus* . .	28·00°/$_0$
Zone of *Cancellaria martiniana* . .	26·18°/$_0$
Zone of *Meiocardia metavulgaris* . .	20·00°/$_0$
Zone of *Mytilus nicobaricus* . . .	26·40°/$_0$

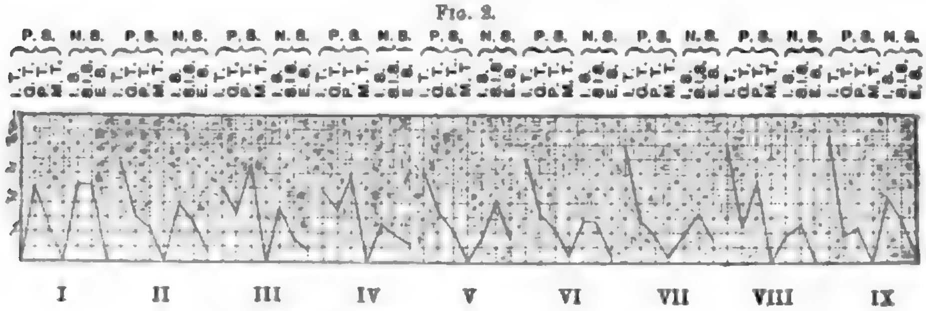
We see that only the two zones of ***Meiocardia metavulgaris*** and ***Arca theobaldi*** exhibit a larger deviation, the former being in defect, the other in excess, yet the zone of ***Meiocardia metavulgaris*** is unquestionably much younger than that of ***Arca theobaldi***, provided of course that the position of the Kama clay as assumed is correct.

The group of the evolutionary species calls for no special remarks, except that the frequency of such species seems independent of the geological horizon.

The group of species not classified can of course not be discussed, because if better preserved the species it contains would come under any of the other three groups.

If we enter the figures of the table on page 75 in a diagram, arranged in the same way as that on page 66, some more interesting facts are exhibited which are not shown by the mere figures.

Fig. 2.



I. Zone of *Cytherea erycina.*
II. Zone of *Aricia humerosa.*
III. Zone of *Pholas orientalis.*
IV. Zone of *Parallelipipedum prototortuosum.*
V. Zone of *Arca theobaldi.*
VI. Zone of *Paracyathus caeruleus.*
VII. Zone of *Cancellaria martiniana.*
VIII. Zone of *Meiocardia metavulgaris.*
IX. Zone of *Mytilus nicobaricus.*

If we again omit the diagram of the zone of *Cytherea erycina* as likely to be erroneous, it will at once be seen that the remaining eight can be arranged into two distinct groups, *viz.*, those having a strongly marked bulging out of the right hand part of the curve, and those in which this part is almost flat.

To the first group belong :—

1. The zone of *Pholas orientalis.*
2. The zone of *Parallelipipedum prototortuosum.*
3. The zone of *Meiocardia metavulgaris.*
4. The zone of *Mytilus nicobaricus.*

To the second group belong :—

1. The zone of *Aricia humerosa.*
2. The zone of *Arca theobaldi.*
3. The zone of *Paracyathus caeruleus.*
4. The zone of *Cancellaria martiniana.*

Now if we compare these diagrams with those on page 66, we see that the first group is similar to the curve of composition shown by the Pelecypoda, and the second one to that of the Gastropoda. We may therefore conclude that in the first diagrams a large number of Pacific types of Pelecypoda occur, which are absent in the second group of diagrams; it is unnecessary to prove this by figures as a reference to the lists Nos. 1 to 8 on pages 68 to 73 will show the correctness of this statement.

The most important fact is, however, the proof that the ***composition of the fauna is entirely independent of its geological position;*** there can be no more different curves of composition than those of the zone of *Parallelipipedum prototortuosum* and *Arca theobaldi*, and yet it is very probable that both horizons are separated only by a small thickness of beds. The same applies to the zones of *Meiocardia metavulgaris* and *Mytilus nicobaricus.*

In conclusion I have in the following table given the total percentage of each of the palæogene and neogene species.

IN PER CENTS.

	Zone of *Cytherea erycina.*	Zone of *Aricia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parallelipipedum prototortuosum.*	Zone of *Arca theobaldi.*	Zone of *Paracyathus caeruleus.*	Zone of *Cancellaria martiniana.*	Zone of *Meiocardia metavulgaris.*	Zone of *Mytilus nicobaricus.*
Palæogene Species . .	39·99	61·44	74·88	70·00	60·28	67·3	64·26	80·00	61·6
Neogene Species . .	59·98	38·42	24·96	29·75	39·48	33·6	35·70	20·00	39·2

It will be seen that, in every case the percentage of palæogene species is considerably in excess of that of the neogene species, by being generally about double the number of the neogene ones, but in a few instances three, even four times this number. It will thus be seen that the proportion of palæogene and neogene species varies a good deal in the different horizons, the zone of ***Parallelipipedum prototortuosum*** exhibiting almost the exact average figures (see page 67). We may further conclude from this table that the proportion of "extinct" to "recent" species, to use this term, is rather an uncertain factor when solely used for the determination of age. According to this principle, the zone of ***Meiocardia metavulgaris*** containing the smallest number of recent species, ought to be the oldest, and the zone of ***Arca theobaldi*** containing the largest number of the same class, the youngest, yet if one fact is certain it is that the zone of ***Arca theobaldi*** is much older than that of ***Meiocardia metavulgaris.*** We arrive therefore at the important result that ***unless supported by stratigraphical observations, the Lyell-Deshayes' rule for ascertaining the age of Tertiary beds is of problematic value*** (see also pages 95 to 98).

Even if we were to add the number of Pacific types to that of the neogene species, in order to bring the figures more in harmony with those of Deshayes, their value would be a very uncertain one, as seen from the following table :—

Percentage of Neogene species + Pacific types.[1]

1. Zone of *Aricia humerosa*	49·94°/$_o$
2. Zone of *Pholas orientalis* . . .	58·33°/$_o$
3. Zone of *Parallelipipedum prototortuosum* .	57·75°/$_o$
4. Zone of *Arca theobaldi*	50·76°/$_o$
5. Zone of *Paracyathus caeruleus* . . .	54·80°/$_o$
6. Zone of *Cancellaria martiniana* . .	45·22°/$_o$
7. Zone of *Meiocardia metavulgaris* . .	48·00°/$_o$
8. Zone of *Mytilus nicobaricus* . . .	49·40°/$_o$

The older beds would according to these figures contain a larger percentage of "recent" species than the geologically younger ones, and if any conclusions were drawn from the fauna of a single horizon, for instance, that of ***Parallelipipedum prototortuosum,*** they would certainly be misleading.

We may summarize the above facts in the following way : The Lyell-Deshayes' rule for determination of the age of Tertiary beds holds good only when an average figure for a larger series has been obtained, provided it is supported by stratigraphical observations.

[1] The zone of *Cytherea erycina* being omitted.

4.—Biological and Bathymetric Character of the Fauna of the Yenangyoungian and Promeian.

(A) *Comparison with the Fauna of the Miocene of Java and the Gajian of Western India.*

In the descriptive part 208 species have been determined which represent the following classes:—

	Number of species.	% of Fauna.
Anthozoa	4	1·92 %
Echinoidea	3	1·44 %
Pelecypoda	85	40·80 %
Gastropoda	96	46·08 %
Crustacea	6	2·68 %
Pisces	10	4·80 %
Reptilia	3	1·44 %
Mammalia	1	0·48 %

The vertebrata, exclusive of four species of Squalidae, have so far only been found in the *Promeian* while the remainder of the fauna occurs in the *Yenangyoungian*, and it is chiefly this fauna on which we can base any conclusions having a certain amount of probability.

From these figures it can be seen that the Pelecypoda and Gastropoda occur in such numbers that the other classes almost completely disappear. The character of the fauna is therefore chiefly moulded by the Pelecypoda and Gastropoda.

The small number of Anthozoa and Echinoidea is very remarkable. The *Gajian* of Sind has yielded according to Duncan and Sladen—

Anthozoa . . . 41 species.
Echinoidea . . . 27 „

The Miocene of Java has yielded[1] according to Martin—

Anthozoa . . . 36 species = 11·73 % } of total fauna.
Echinoidea . . 19 „ = 6·19 % }

Unfortunately the fauna of the *Gajian* is so little known that the number of Anthozoa and Echinoidea cannot be expressed in per cents. in order to allow for a better comparison with the same figures obtained for the fauna of the *Yenangyoungian* and the Miocene of Java, yet I can confidently say that the percentage of the total fauna is not expressed by such a low figure as obtained for the *Yenangyoungian*, though it may perhaps be higher than that from Java.

There are only two ways of accounting for this scarcity of *Anthozoa* and *Echinoidea* in the Yenangyoungian. Either the horizon in which these classes occur more frequently has not been discovered yet, or if not restricted to a certain horizon the *Yenangyoungian* as a whole is developed in a facies which is not favourable to

[1] Tertiärschichten auf Java, General part, page 28.

the existence of such large numbers of Anthozoa and Echinoidea as occurring in Java and Western India.

We shall presently see that there are several circumstances in favour of the first view. Professor Martin enumerates a number of species, among which there are several Anthozoa and Echinoidea from the Miocene of Java, as common to the *Gajian* in Western India. *None* of these species have been found in Burma, and the probability that they represent a horizon, which if present has not been found, is by no means small.

On the other hand the theory of a different facial development cannot be put aside without further consideration. We shall presently see that the character of the fauna of the *Yenangyoungian* is distinctly littoral, no coral reef having been discovered yet; on the other hand it seems almost certain that the majority of the Anthozoa and Echinoidea from Western India came from coral reefs, while the same probably applies also to Java (*vide* Korallenkalke Martin, Tertiärschichten auf Java, General part, page 4).

We may perhaps combine both views, and suppose that the equivalent of the lower part of the *Pegu* Division which is represented by the unfossiliferous *Promeian* contains in Java and Western India coral reefs. This theory is, however, not supported by palæontological evidence, because some of the species which Martin mentions in addition to the Anthozoa and Echinoidea occur in Baluchistan according to my own observations high up in the series of the *Gajian*. We shall see further on that another observation, Mr. Theobald's find of a *Pseudodiadema spec.* in the upper part of the *Pegu* group, renders the theory that the *Promeian* is the estuarine facies of the marine "Korallenkalke" of Java and the lower *Gajian* of Western India very improbable. This is, however, a point on which it is useless to speculate any further, as it can only be solved by future researches in the field, the direction which these researches will have to take being clearly indicated by the above arguments.

The following table gives a comparison of the fauna of the *Yenangyoungian* and the miocene of Java[1] in per cents. of the total number :—

	Yenangyoungian + Promeian.	Yenangyoungian.	Miocene of Java.
Foraminifera	*Nil.*	*Nil.*	1·95 %
Anthozoa	1·92 %	2·02 %	11·73 %
Echinoidea	1·44 %	1·51 %	6·19 %
Brachiopoda	*Nil.*	*Nil.*	0·82 %
Pelecypoda	40·80 %	42·92 %	24·12 %
Gastropoda	46·08 %	48·48 %	52·16 %
Cephalopoda	*Nil.*	*Nil.*	0·32 %
Crustacea	2·88 %	3·03 %	2·93 %
Pisces	4·80 %	2·02 %	*Nil.*
Reptilia	1·44 %	*Nil.*	*Nil.*
Mammalia	0·48 %	*Nil.*	*Nil.*

[1] Martin, Tertiärschichten auf Java, General part, page 28.

It will be seen from these figures, that though differing somewhat in detail, the Miocene from Java shows the greatest similarity with the *Yenangyoungian*, by the great preponderance of the Pelecypoda and Gastropoda. In the *Yenangyoungian* the percentage of Pelecypoda and Gastropoda is 91·4 per cent., while in Java it is slightly smaller, being 76·18 per cent. only.

The differences consist chiefly in the greater percentage of Anthozoa, Echinoidea, the presence of Brachiopoda and Cephalopoda, all of which speak in favour of a coral reef facies; while in the Miocene of Burma the occurrence of mammalia indicates perhaps an estuarine horizon. A similar horizon has, however, been subsequently discovered in Java.[1]

(B) *The Bathymetric Character of the Fauna of the Yenangyoungian.*

The vertical distribution, in connection with the character of the fauna, proves that two different facies are represented in the *Yenangyoungian*, viz. :—

(*a*) A purely marine facies,
(*b*) An estuarine facies,

and if any conclusions are to be drawn with regard to the bathymetric conditions under which the *Yenangyoungian* has been deposited, the two facies have to be separately considered.

(*a*) *The marine facies.*

It appears that the marine facies has formed under two different conditions, *viz.*, a shallow water facies characterised by *Ostrea*-beds, and a facies probably deposited in a depth not exceeding 25 metre.[2]

(*aa*) The shallow water facies.

Unfortunately no actual observations are available with regard to the occurrence of this facies; we even do not know the position it holds in the sequence of the series. In lower Burma it is apparently represented by *Ostrea*-beds, chiefly composed of *Ostrea peguensis*, spec. nov., and *Ostrea promensis*, spec. nov. Most probably these *Ostrea*-beds contained no other species except the large *Pecten protosenatorius*, spec. nov. Nothing is known about the vertical position of these beds; we even do not know whether the two species characterise different horizons or not, yet it seems very probable to me that they occur above the zone of *Arca theobaldi*, indicating the change which is gradually preparing towards the top of the *Yenangyoungian*. The occurrence of this facies in upper Burma has not been proved yet; it is certainly absent in all the sections I examined.

(*bb*) The littoral facies.

Strata belonging to this facies appear to constitute the larger portion of the *Yenangyoungian* in lower and upper Burma, and it is chiefly this facies which contains the rich fossiliferous horizon.

[1] Martin, Tiefbohrungen auf Java, page 324.
[2] There may be, as pointed out on page 81, a third coralline facies, though this view requires further confirmation, there being at present no evidence to prove its existence.

The fauna exhibits, however, a peculiarity; with the exception of ***Pyrula pugilina***, ***Pyrula bucephala*** and ***Pyrula pseudobucephala*** all the species examined are of small size showing a delicate ornamentation. Strong robust species are entirely absent. A further characteristic feature is the frequency of single corals like ***Ceratotrochus alcockianus***, spec. nov., ***Paracyathus caeruleus***, Dun., or of genera like ***Nucula***, ***Leda*** or ***Dentalium*** and ***Basilissa*** which generally occur in deep water. On the other hand this element of the deeper regions is fully counteracted by genera which habitually frequent the shallow water.

If we go through the lists of fossils as given on pages 20 to 36 we see that whatever species occur, there are always some genera which do not go beyond 25 metre in depth, and we must therefore assume that none of the beds were deposited in a greater depth.

The following table shows the character of the fauna of each horizon; in the left-hand part the actual figures are given, in the right-hand part the per cents. by which each class is represented in the total of the fauna :—

Actual number.

	Zone of *Cytherea erycina.*	Zone of *Aricia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parallel. protortuosum.*	Zone of *Arca theobaldi.*	Zone of *Anoplotherium birmanicum.*	Zone of *Cancellaria martiniana.*	Zone of *Paracyathus caeruleus.*	Zone of *Dione dubiosa.*	Zone of *Meiocardia metavulgaris.*	Zone of *Mytilus nicobaricus.*	Zone of *Cardita tjidamarensis.*	Zone of *Cyrena crawfurdi.*
Anthozoa	2	1	1	3	1	1	1	2	...	1	1	...	...
Echinoidea	...	...	...	1	2	...	...	...	...	...	...	...	...
Pelecypoda	7	14	22	34	19	5	9	9	3	19	19	1	3
Gastropoda	11	15	5	23	34	...	35	29	1	8	19	...	...
Crustacea	1	1	...	2	2	...	3	2	...	2	1	...	...
Pisces	...	...	...	...	...	3	4	4	...	2	2	...	...
Reptilia	...	...	...	...	...	3	...	...	...	...	...	...	...
Mammalia	...	...	...	...	...	1	...	...	...	...	...	...	...

In per cents.

	Zone of *Cytherea erycina.*	Zone of *Aricia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parallelipipedum protortuosum.*	Zone of *Arca theobaldi.*	Zone of *Anoplotherium birmanicum.*	Zone of *Cancellaria martiniana.*	Zone of *Paracyathus caeruleus.*	Zone of *Meiocardia metavulgaris.*	Zone of *Mytilus nicobaricus.*
Anthozoa	9·52	3·23	3·56	4·74	1·72	7·7	1·92	4·34	3·12	2·38
Echinoidea	...	...	...	1·58	3·44	...	...	...	...	...
Pelecypoda	33·33	45·08	78·32	53·78	32·68	38·5	17·30	19·53	58·28	45·22
Gastropoda	52·36	48·30	17·80	36·34	58·48	...	67·30	62·93	24·96	45·22
Crustacea	4·76	3·22	...	3·16	3·44	...	5·76	4·34	6·24	2·38
Pisces	...	...	...	...	...	23·1	7·69	8·68	6·24	4·76
Reptilia	...	...	...	...	...	23·1	...	...	...	...
Mammalia	...	...	...	...	...	7·7	...	...	...	...

* On account of the small number of species no per cents. are given of the zones of *Dione dubiosa*, *Cardita tjidamarensis*, *Cyrena crawfurdi*.

These figures prove that though varying considerably in detail, the general

character of the faunas represented by the various fossiliferous horizons[1] is very much the same. In all horizons the Pelecypoda and Gastropoda are greatly in excess of the other classes. It may happen that in some instances the Pelecypoda are greatly in the majority (zone of *Parallelipipedum prototortuosum*) while in others the reverse takes place (zone of *Arca theobaldi*), but if the two classes are added up the total is much the same in each horizon.

We can therefore conclude that all the fossiliferous horizons from the lowest of the zone of *Cytherea erycina* up to the highest of *Mytilus nicobaricus* were deposited under much the same conditions, in water which did not exceed 25 metre in depth on a sandy shore. Now as we know that at least during the lower half of a series, measuring about 2,500 feet in thickness, fossiliferous horizons of the same character are distributed from the bottom to the top, we must conclude that the *Yenangyoungian* represented a period of perhaps rapid subsidence. This theory fully accounts for the quick change indicated by the differently composed faunas of the succeeding horizons.

(*b*) *The Estuarine facies.*

As far as I know, this facies is only developed in upper Burma, and unknown in lower Burma, but this does not prove its non-existence. The brackish facies is characterised by unfossiliferous beds containing gypsum; only here and there *Cyrena*-beds occur in patches in which *Cyrena petrolei*, Noetl., and *Cyrena crawfurdi*, Noetl., are found by the thousands. The zone of *Cardita tjidamarensis* from Singu represents probably also this facies, though this is not quite certain.

This facies must have been formed under similar conditions as prevail at present in the large estuarines of the Ganges, Brahmaputra or Irrawaddi.

(*C*) *The Bathymetric Character of the Fauna of the Promeian.*

Only one fossiliferous horizon has so far been discovered in the *Promeian*, the zone of *Anoplotherium birmanicum*, spec. nov., which has been discovered 150 feet from the top of the *Promeian* in the Yenangyoung oil-field. The composition of its fauna is very peculiar and completely differs from any of the faunas known from the *Yenangyoungian*, as can be seen from the following figures:—

	Actual number.	in %
Anthozoa	1	7·7%
Echinoidea	...	...
Pelecypoda	5	38·5%
Gastropoda	...	...
Crustacea	...	...
Pisces	3	23·1%
Reptilia	3	23·1%
Mammalia	1	7·7%

[1] Of course horizons like that of *Dione dubiosa* containing only a few species cannot be compared with those containing a larger number, or totally wrong conclusions would be arrived at.

Taking it as a whole we have a mixture of purely marine organisms with terrestric animals represented by the mammalia. The marine species are exactly the same as those occurring in the younger zones, thus proving their close palæontological connection, but the mammalia represent an absolutely foreign element. Most of the species are represented by fragments of bones only, some of them rolled and worn, but others are exceedingly well preserved, hardly showing any signs of wear and tear. Now, how are we to account for this terrestric element among a fauna which could not have possibly existed in any but pure marine water?

The easiest explanation is of course to attribute an estuarine origin to the beds in which this zone occurs, assuming that the fragments of the terrestric animals were carried out to sea by rivers. The character of the invertebrata is, however, decidedly against such a theory. Corals cannot exist anywhere in brackish water.

Now Fuchs[1] has shown that far from the coast at great depths terrestric plants and fragments of terrestric animals have been found by the Challenger expedition and others. Terrestric remains can therefore also occur in purely marine sediments, not only in those of estuarine or fluviatile origin. We must therefore claim a marine origin for the zone of ***Anoplotherium birmanicum*** and probably one of deep water into which the terrestric remains were accidentally deposited.

Whether a similar composed fauna occurs in the lower beds of the ***Promeian*** remains to be seen, the sections from the bore holes in upper Burma having so far proved unfossiliferous, and no observations regarding fossiliferous beds from the series below Mr. Theobald's ***Cytherea promensis***-bed are known from lower Burma. One fact, however, remains certain, the transport of terrestric remains ceased with the termination of the ***Promeian***.

I think that the zone of ***Anoplotherium birmanicum***, which concludes the ***Promeian***, already foreshadows by its marine organisms the conditions which we meet in the ***Yenangyoungian***, yet at the same time indicates the conditions which prevailed during the deposit of the ***Promeian***. So far we know very little about these conditions, but the occurrence of coal seams and petroliferous beds shows that the ***Promeian*** was probably formed in an extensive estuarine into which rivers brought a great quantity of vegetabilic and animalic remains.

5.—Comparison of the Fauna of the Pegu Division with the Fauna of the Miocene in Europe, of the Fauna of the Indian Ocean, the Gajian of Western India, and the Miocene of Java.

(*A*) *The Fauna of the Yenangyoungian.*

(*a*) Comparison with the Miocene Fauna of Europe and the Fauna of the Indian Ocean.

The determination of the fauna soon proved that there was not a single species

[1] Neues Jahrb. für Min. Geol. und Petref. 1883 Beilage, Band II., pages 498—499.

in common with the Miocene of Europe. There exists a certain relationship with the fauna of the European Eocene, which has already been discussed, but though such a connection is undeniably existing, no species are actually in common. We may therefore conclude that during the Miocene period the Indian province of the ocean was already well separated from that of Europe.

A similar conclusion has already been arrived at by Professor Martin[1] with regard to the fossils from the Miocene of Java, who proved that it shares not a single species with the Miocene of Europe.

On the other hand, the fauna of the *Yenangyoungian* bears a close relationship to the present fauna of the Indian Ocean; 30 per cent. of the species described are either identical or so closely related to living species, that they might be considered as identical with species inhabiting at present the Indian Ocean. In several instances, aggregating to 15·12 per cent. of the total number of Pelecypoda and Gastropoda, the Miocene species could be proved to be the direct ancestors of species inhabiting the Indian Ocean. If we assume that a part of the fauna of the Indian Ocean has directly descended from the Miocene fauna of India and Burma, this theory is well supported by facts.

Professor Martin has come to the same conclusion with regard to the fauna of the Miocene of Java. On page 39, General part, of the Tertiärschichten auf Java he writes: "so dass der Character der miocänen Fauna Javas nicht nur mit dem der indopacifischen übereinstimmt, sondern speciell die nächste Verwandtschaft zur Fauna desjenigen Meeres zeigt, welches noch heute die Küste Javas umspült." Now it will be admitted that if two different authors at different times and by different ways arrive at the same result with regard to the fauna of a certain period, such result is very possibly correct.

We may therefore say, that at least a part of the present fauna of the Indian Ocean bears an archaic character, and is directly derived from the Miocene fauna occurring in India, Burma, Sumatra and Java.

On the other hand, a theory, which I think was first promulgated by Jenkins[2] and which has since been accepted in all manuals, assumes that the fauna of the European Miocene is closely related to the fauna of the Indian Ocean. In the light of the researches with regard to the fauna of the *Yenangyoungian* it is not easy to reconcile both theories if we keep in mind that the *Yenangyoungian* has not a single species in common with the European Miocene. It might be argued that if the fauna of the European Miocene is closely related to that of the Indian Ocean, we should necessarily expect European Miocene species among the fauna of the *Yenangyoungian*, because this fauna bears unquestionably the strongest relationship with the fauna of the Indian Ocean. No such species have, however, been found, but how is then the relationship of the European Miocene fauna and that of the Indian Ocean to be explained? I think the following theory of accounting for such a relationship without interfering with the view that

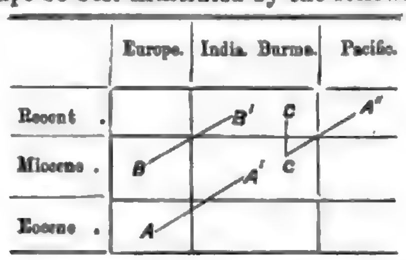
[1] Tiefbohrungen auf Java, page 355.

[2] Quart. Journ. of Geol. Soc. London, 1864, Vol. XX., page. 62

at least part of the fauna of the Indian Ocean is an indigenous one, will solve the difficulty. Several observations tend to prove that the present fauna of the Indian Ocean contains a foreign element, which is apparently not represented in the fauna of the local Miocene. The examination of the Miocene species of the genus ***Ostrea*** has unquestionably proved that none of them has the slightest relationship with those living in the Indian Ocean; in fact these species represent a different element which must necessarily have migrated to its present habitat from somewhere else, and I think these instances will increase once the Miocene fauna of India is better known.

On the other hand we see (page 54) that the fauna of the *Yenangyoungian* bears a remarkable relationship to the fauna of the Eocene of France, which can only be explained by a migration from west towards east which probably began with the Eocene time. I have further proved that there is a great deal of evidence to show that a further migration of species took place since the Miocene time from Burma towards the Pacific region (page 60). Now if we suppose that this migration continued during the Miocene time from Europe towards India, the fauna of the European Miocene would stand in the same relation to the fauna of the Indian Ocean, as the fauna of the Miocene of Burma stands to the recent fauna of China, Japan and Philippines.

This view will perhaps be best illustrated by the following diagram :—



Let A represent any number of species occurring in the Eocene of Europe; during the migration towards east, this group became modified and is represented by species A′ in the Miocene of India-Burma and by the still further modified species A″ among the recent fauna of China, Japan, Philippines. B represents any number of species from the European Miocene which in the fauna of the Indian Ocean are represented by B′; C represents the number of species the fauna of the Miocene India-Burma has in common with the fauna of the Indian Ocean, in other words its *indigenous* element, while B′ represents the *foreign* element. The fauna of the Indian Ocean is, therefore, represented by the symbol B′C while that of the Miocene of India is represented by the symbol A′C. The relations of each fauna to chronologically older and younger faunas in Western and Eastern direction are thus clearly expressed, and though both faunas are intimately connected by the species in common C, each has its own characteristic features in A′ and B′ of which B′ cannot possibly occur in the fauna A′C.

It is only by this theory of migration from West to East, which began probably with the Eocene, and lasted throughout the Miocene, that the relationship of the fauna of the Indian Ocean, both with the Miocene of Europe and of Burma-India,

can be explained without there being a single species in common. This theory could easily be verified if the fauna of the European Miocene will be examined in a similar way as that of the Miocene of Burma.

(b) *Comparison with the Fauna of the Gajian of Western India.*

The relationship of the fauna of the *Yenangyoungian* with that of the *Gajian* or the Miocene of Western India remains now to be examined. It must, however, be kept in mind that with regard to the fauna of the *Gajian* the results of such a comparison will be much less conclusive, than those with regard to the Miocene of Java; its fauna being very little known; and if at present only a small number of species can be proved to be common to the *Yenangyoungian* and *Gajian*, this number will perhaps be increased after the fauna of the *Gajian* is better known. On the other hand, it is not very probable that the number of species in common with the Miocene of Java will be much increased. This fauna is now so well known through the researches of Professor Martin, that unless other fossiliferous horizons are discovered in Burma which contain a larger number of species in common with Java, the results arrived at by my examination are fairly reliable.

The following table contains the species in common with the *Gajian*, showing at the same time their geological occurrence in Burma.

NAME OF SPECIES.	Zone of *Cytherea erycina.*	Zone of *Aricia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parallelipipedum prototortuosum.*	Zone of *Arca theobaldi.*	Zone of *Paracyathus caeruleus.*	Zone of *Conellaria martiniana*	Zone of *Meiocardia metavulgaris.*	Zone of *Mytilus nicobaricus.*	Uncertain.
1. *Arca burnesi*, d'Arch. and Haime.	.	.	.	●	.	.	.	.	.	.
2. " *peethensis*, d'Arch. and Haime.	.	.	●	●	.	.	.	.	.	●
3. *Cardita viquesneli*, d'Arch. and Haime	.	●	.	●	.	.	.	.	.	.
4. " cf. *mutabilis*, Arch. and Haime.	.	.	.	.	.	.	.	●	●	.
5. *Venus granosa*, Sow.	.	.	.	.	.	.	.	.	.	●
6. *Corbula rugosa*, Sow.	.	.	.	.	.	.	.	●	●	.
7. *Solarium maximum*, Phil.	.	.	.	●	●	●	●	●	●	.
8. *Natica callosa*, Sow.	●	●	.	●	●	●	●	.	.	.
9. " *obscura*, Sow.	●	●	●	●	●	●	●	.	.	.
10. *Cypraea granti*, d'Arch. and Haime.	.	.	.	.	.	●	●	●	●	.
11. *Aricia humerosa*, Sow. spec.	.	●	.	.	.	.	.	.	.	.
12. *Cassis d'archiaci*, Noetl. = *Cassidaria carinata*, d'Arch. and Haime.	.	.	.	.	.	.	●	.	.	.

NAME OF SPECIES.	Zone of *Cytherea erycina.*	Zone of *Aricia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parallelipipedum prototortuosum.*	Zone of *Arca theobaldi.*	Zone of *Paracyathus caeruleus.*	Zone of *Cancellaria martiniana.*	Zone of *Meiocardia metavulgaris.*	Zone of *Mytilus nicobaricus.*	Uncertain.
13. *Ranella prototubercularis*, spec. nov. = *Ranella viperina*, d'Arch. and Haime.	·	·	·	●	●	●	·	·	·	·
14. *Fasciolaria nodulosa*, Sow.	·	·	·	·	·	·	●	·	·	·
15. *Murex tchihatcheffi*, d'Arch. and Haime.	·	·	·	·	·	●	·	·	·	·
16. *Voluta dentata*, Sow.	·	·	·	·	·	●	●	·	·	·
17. *Cancellaria davidsoni*, d'Arch. and Haime, spec.	·	·	·	·	·	●	●	·	·	·
18. *Strioterebrum protomyuros*, spec. nov. = *Terebra reticulata*, Sow.	·	·	·	·	●	·	·	·	·	·
19. *Conus literatus*, Linné = *Conus breis*, Sow.	·	●	·	·	·	·	·	·	·	·
20. *Balanus tintinnabulum*, Lin. = *Balanus sublaevis*, Sow.	●	●	·	●	●	●	●	●	●	·

Considering the limited vertical range the fossils have in Burma, we may conclude from the above list, that all the main fossiliferous horizons as observed in Burma are also represented in the *Gajian*, but until the vertical distribution of the fossiliferous horizons in that group is better known than at present, it would be rash to form any conclusions.

A more remarkable feature is the composition of the above list; though all the groups distinguished in the preceding chapter are represented, the Gastropoda are in a much larger number than the Pelecypoda. The proportion being 2·16 : 1, while the same proportion in the fauna of the *Yenangyoungian* is 1·13 : 1; therefore if the same proportion were to exist among the species the *Yenangyoungian* has in common with the *Gajian*, the number of Pelecypoda ought to be 11, instead of 6 as recorded.

This preponderance of the Gastropoda is a fact which cannot be accounted for at present. After I had noticed it, I carefully revised my determinations in order to see whether I was wrong or not, but I discovered no reason why I should alter my views. It remains to be seen whether this remarkable feature really exists or is only an apparent one, because Sowerby and d'Archiac described only a small number of Pelecypoda in proportion to the actual number occurring.

(c) *Comparison with the Fauna of the Miocene of Java.*

On the following list the species in common with the Miocene of Java are given, showing at the same time the geological occurrence in Burma :—

NAME OF SPECIES.	Zone of *Cytherea erycina.*	Zone of *Arcia humerosa.*	Zone of *Pholas orientalis.*	Zone of *Parallelepipedum proto-tortuosum.*	Zone of *Arca theobaldi.*	Zone of *Paracyathus caeruleus.*	Zone of *Cancellaria martiniana.*	Zone of *Meiocardia metavulgaris.*	Zone of *Mytilus nicobaricus.*	Zone of *Cardita tjidamarensis.*	Uncertain.
1. *Flabellum distinctum*, Milne Edwards.	●	●	●	●	·	·	·	·	·	·	·
2. *Arca nannodes*, K. Martin.	·	·	·	·	●	·	·	·	·	·	·
3. „ *bataviana*, K. Martin.	·	·	·	·	●	·	·	·	·	·	·
4. „ *thayetensis* spec. nov. = *Arca rustica*, K. Martin (?).	·	·	·	·	·	·	·	·	·	·	●
5. *Leda virgo*, K. Martin.	·	·	·	·	●	·	●	·	·	·	·
6. *Cardita tjidamarensis*, K. Martin.	·	·	·	·	·	·	·	●	·	●	·
7. *Dione protolilacina*, spec. nov. = *Cytherea lilacina*, K. Martin.	●	·	●	●	●	·	·	●	●	·	·
8. *Corbula socialis*, K. Martin.	·	·	●	●	●	·	·	·	·	·	·
9. *Dentalium junghuhni*, K. Martin.	·	·	·	●	·	·	·	·	●	·	·
10. *Solarium maximum*, Phil. = *Solarium perspectivum*, K. Martin (?).	·	·	·	·	●	●	●	●	●	·	·
11. *Scalaria birmanica*, Noetl. = *Scalaria samarangana*, K. Martin (?)	·	·	·	●	·	·	●	·	·	·	·
12. *Turritella simplex*, Jenk.	·	·	·	●	●	·	·	·	●	·	·
13. „ *acuticarinata*, Dunk.	·	·	·	●	●	·	·	·	·	·	·
14. *Vermetus javanus*, K. Martin.	●	●	·	●	·	·	·	·	·	·	·
15. *Trivia smithi*, K. Martin.	·	·	·	·	·	●	·	·	·	·	·
16. *Ranella prototubercularis*, spec. nov. = *Ranella junghuhni*, K. Martin.	·	·	·	●	●	●	●	·	·	·	·
17. *Ranella elegans*, Beck.	●	●	·	●	·	·	·	·	·	·	·
18. *Fusus verbeeki*, K. Martin.	·	●	·	·	·	·	·	·	·	·	·
19. *Pyrula bucephala*, Lamarck.	·	·	·	·	·	·	·	·	●	·	·
20. *Oliva rufula*, Ducl.	·	●	·	●	●	●	●	·	·	·	·
21. *Ancillaria cf. vernedei*, Sow.	●	●	●	·	·	·	·	·	·	·	·
22. *Strioterebrum bicinctum*, K. Martin.	·	·	·	·	●	·	·	·	·	·	·
23. *Terebrum protoduplicatum*, spec. nov. = *Terebra bandangensis*, K. Martin (?).	·	·	·	·	●	·	·	·	·	·	·
24. *Terebrum smithi*, K. Martin.	·	·	·	·	●	·	●	·	·	·	·
25. *Drillia protointerrupta*, spec. nov. = *Pleurotoma interrupta*, K. Martin.	·	·	·	·	·	·	●	·	·	·	·
26. *Ringicula turrita*, K. Martin.	·	·	·	●	·	·	·	·	·	·	·
27. *Balanus tintinnabulum*, Linné.	●	●	·	●	●	●	●	●	●	·	·

The above list contains 28 species, the majority of which occur in the zones of *Parallelipipedum prototortuosum* and *Arca theobaldi;* but we see that the other horizons are also represented, and if we consider the limited vertical range of the species as observed in Burma, which did not allow even for a correlation of the different horizons in Burma itself, it is obvious that an attempt to trace in Java the horizons distinguished by me in Burma would be more than hazardous. *All we can say is that taken as a whole the Yenangyoungian is correlated to the Miocene of Java, or at least part of it.*

It seems that in the Miocene of Java certain beds are developed which are either not developed in Burma or have not been discovered yet. On page 26, General part, Tertiär. auf Java, Martin mentions the following species as identical with species from the *Gajian*:—

Turritella angulata, Sow. (?)	*Cytherea ventricola*, Mart. (?)	*Phyllacanthus baculosa*, Ag. (?)
Bulla javana, K. Mart. (?)	*Ostrea hyotis*, Linn.	*Clypeaster humilis*, Ag.
Septaria arenaria, Lamk.	" *lingua*, Sow.	*Echinolampas oviformis*, Ag.
Corbula trigonalis, Sow.	*Balanus tintinnabulum*, Lin.	*Breynia magna*, Mart.
Clementia papyracea, Gray.	" *amaryllis*, Darw.	*Maretia planulatta*, Gray.

None of these species have been known from Burma except *Turritella angulata*, Sow., and *Balanus tintinnabulum*, Lin.; the exact horizon of the former species is not known and the latter species has apparently a wide, vertical and horizontal range; *Phyllacanthus baculosa*, Ag., may perhaps be identical with the species here described as *Cidaris spec.* 1, yet the identification of these species, with those observed in Western India, is not beyond any doubt as expressed by the query except that of *Balanus tintinnabulum*, Lin.

It appears therefore that in the Miocene of Java, a number of species occur which, though identical with species from Western India, have not been found in Burma. The great question now arises, do these species represent a certain horizon or not? At present this question cannot be answered one way or the other decisively; yet there seems to be quite a distinct hint as to its solution, particularly if we further consider Martin's list of species from Western India, which, though not identical with Javan fossils, are closely related to them.

Among the second list *Vicarya verneuilli*, d'Arch. and Haime, is mentioned. Now this species occurs in Baluchistan, together with *Turritella angulata* and *Ostrea lingua*, Sow., very high up in the series directly below the Siwaliks, though the thickness of beds in which these species occur is considerable. It is unquestionable that this horizon is not represented among those I described, though it is probably represented in lower Burma as is indicated by the occurrence of *Turritella angulata*, the exact stratigraphical position of which is unfortunately not known. The greatest probability is in favour of the view that this horizon occurs above the zone of *Arca theobaldi*, somewhere in the series called *Thayetmyo*-sandstone. If this view be correct, a part of Martin's species would represent beds which could be correlated to the upper part of the *Yenangyoungian* from which no fossiliferous horizons are known yet, though they may be discovered in future.

Another feature of Martin's list is also remarkable; in his first list five Echinoidea are mentioned, that is to say, the Echinoidea make 33°/₀ of the total number of fossils identical with those from the *Gajian*. Now in the total number of fossils described from the *Yenangyoungian* the Echinoidea form such an insignificant number, that their absence is one of the most conspicuous features. Unfortunately nothing is known as to the vertical distribution of the Echinoidea in the *Gajian*, and I am, therefore, not in the position to say whether the occurrence of the Echinoidea in the *Gajian* represents a facies not developed in Burma, or forms the characteristic features of a horizon which does not occur in Burma. These views may also refer to Java, and the reason why a good number of the species which the Miocene of Java has in common with the *Gajian* do not occur in Burma, may either be the non-development of the same facies, or the non-occurrence of the same horizon.

A hint to the solution of this problem is perhaps given by Mr. Theobald's find of Echinoidea, particularly a *Pseudodiadema spec.*, in beds which he declares to occur in the upper part of the *Pegu* group. If these are the same specimens which are among Mr. Theobald's collection, they must have been labelled wrongly; they are, however, too ill-preserved to allow of any definite view, yet the probability that this horizon represents the facies of which I have been just speaking, is by no means small, and its occurrence in the upper part of the *Yenangyoungian* would fully agree with the opinion formed from the occurrence of species like *Turritella angulata* and *Vicarya verneuilli*. It is useless to speculate any further on this problem, which can only be solved by actual researches.

If we examine the composition of the fauna the *Yenangyoungian* has in common with the Miocene of Java, we observe almost the same proportion between Pelecypoda and Gastropoda as we noticed among the species common with the *Gajian*. The proportion of Gastropoda to Pelecypoda is 2·57 : 1, while as we have seen it ought to be 1·13 : 1.

The fact that the Gastropoda are so considerably in the majority of species the *Yenangyoungian* has in common with the *Gajian* and the Miocene of Java is certainly very remarkable. The only explanation I can offer is the theory of the great change the Pelecypoda underwent during the Miocene time while the Gastropoda remained more stable. This view would account for the small number of identical Pelecypoda, as well as for the larger number of identical Gastropoda.

If we now compare those species which were found to be identical with the fauna of the *Gajian*, with those which are identical with the Miocene from Java, we find that it is almost the same number which the *Yenangyoungian* has in common with both countries, particularly if we take only the number of mollusca in consideration. Whether this similarity in number is only accidental, or really exists, I am unable to say. It might of course be expected that the Miocene of Burma, which is about half way between Java and Western India, contains a certain number of species in common with either country, yet it would seem remarkable if it were almost the same.

This fact seems the more strange as the species in common with the Miocene of Java are perfectly different from those in common with the *Gajian*. There seem to be only three species which the *Gajian* has in common with the *Yenangyoungian* and the Miocene of Java; these are—

Solarium maximum, Philippi.
Ranella prototuberculаris, spec. nov.
Balanus tintinnabulum, Linné.

The identity of the two first named species, though undoubted with regard to the *Gajian*, is not beyond question with regard to the Miocene of Java. I supposed that the species described by me as *Solarium maximum*, Phil., is probably identical with *Solarium perspectivum*, K. Mart., and *Ranella prototuberculаris*, probably with *Ranella junghuhni*, K. Mart., but I cannot state with certainty that this view is correct. If these species are not identical, *Balanus tintinnabulum* would be the only species which is common to the *Gajian*, the *Yenangyoungian* and the Miocene of Java.

We see therefore that though in a general way we can correlate the *Yenangyoungian* to the Miocene of Java and to the Miocene of Western India (*Gajian*), we have no fossil evidence which would directly prove the correlation with the Miocene of Europe, and in order to obtain this end, we must resort to a different argumentation.

(*B*) *The Fauna of the Promeian.*

The small number of Pelecypoda and Gastropoda hitherto obtained from this sub-division renders a correlation of course impossible, particularly as all the species are the same which occur in higher horizons.

The *Promeian* unquestionably represents the lower Miocene of Burma, but I am not in a position to state to which part of the Miocene of Java or the *Gajian* it can be correlated; the probability that it represents a facies which is not developed in either Java or Western India is by no means small, but further stratigraphical observations with regard to Java and Western India are required before any definite opinion can be given.

6.—Determination of the Age of the Yenangyoungian by the Lyell-Deshayes' Law of Percentage.

On page 16 I have fixed the position of the beds from which the fauna described on the following pages has been obtained, as younger than Eocene but older than Pliocene. The stratigraphical probability that the *Pegu* Division represents the Miocene is therefore very great, but it must be determined whether this view is also borne out by the character of the fauna, that is to say, whether the percentage of species identical with recent ones is the same as that recognised for the Miocene of Europe.

Sir Charles Lyell's sub-division of the Tertiary system into the three groups,

Eocene, Miocene, and Pliocene,[1] is chiefly based on the researches of Deshayes, who after a comparison of 3,000 tertiary and 5,000 recent species could prove a gradual increase in the number of recent species from the Eocene to the Pliocene. These figures, which are for the—

Pliocene	35—50 °/₀	of recent species,
Miocene	17—25 °/₀	"
Eocene	3·5— 5 °/₀	"

have now been generally accepted, though at the time they did not remain unchallenged. They appear to answer fairly well to the conditions in Europe, but the great question arises: Do the same figures also apply to the Tertiary system outside the European Continent?

A definite answer to this question is of course of vital importance, if we wish to apply this rule to the Tertiary system of Burma and if we do not want to arrive at a totally wrong conclusion.

Before entering into a discussion on this question, it seems to me of fundamental importance to know the region from which the 5,000 recent species which served Deshayes as material for comparison came. Unfortunately, I am not able to form any opinion on this very important subject, but I think I am not wrong if I suppose that Deshayes' collection of recent species was not solely composed of species living in that oceanic region which is the nearest to the countries from which he obtained his fossil specimens, that is to say, the Lusitanian and Celtic Provinces. I rather believe that he also, and in a goodly number too, compared the fossil species with species from the Indian Ocean. If this view be correct, the value of the above figures loses considerably in importance, because it does not appear justifiable to compare the fauna of a certain Tertiary series in a certain country with a recent fauna composed of elements collected all over the world. If the percentage of recent species is considered as a criterion, these species ought to be such which occur in the nearest oceanic province. Deshayes' figures ought, therefore, to be revised from this point of view, and it may perhaps be questioned whether they could be applied at all when dealing with countries outside Europe.

We have seen above, page 67, that the neogene species form 30°/₀ of the total of the molluscan fauna. According to Deshayes' figures the *Yenangyoungian* could therefore not be older than Miocene; on the other hand, the species which I termed neogene are probably not quite identical with Deshayes' "recent" species, inasmuch as they only refer to species from the nearest oceanic provinces, while Deshayes' "recent" species most probably include a number of species which have at present died out in the Lusitanian and Celtic Provinces. These species would, therefore, be represented in the fauna from Burma by the group which I termed "Pacific types", and in order to bring the figures I arrived at in harmony with those of Deshayes, their number with 18·6°/₀ ought to be added to that of the neogene species. The

[1] Principles of Geology, 1st Edition, Volume III, Appendix, and also Manual of Elementary Geology, page 110.

species would thus be brought to 48·6 °/。 and according to Deshayes' figures we had to consider the *Yenangyoungian* as *Pliocene.*

The results obtained if solely the percentage of "recent" species is taken into consideration are therefore widely different; if we compare the fauna of the *Yenangyoungian* with the fauna of the Indian Ocean only, a *Miocene* age would be deduced, but if compared with the fauna of the Indian Ocean and the Western part of the Pacific, a *Pliocene* age would result. But one view only can be correct, and it remains to be seen which of the two has the greatest probability, by considering the stratigraphical conditions.

We have seen above, pages 4 and 38, that there is the greatest probability of an unconformity between the *Yenangyoungian* and the *Irrawaddi* series, that therefore, disregarding any other characters, it would be impossible to consider both as parts of one and the same series. It would go against every observation, if we were to consider the *Yenangyoungian* as the lower part of the *Irrawaddi* series. If one fact is certain, it is that there exists a great difference between the *Irrawaddi* series and the *Yenangyoungian.* Now it is also almost certain that the *Irrawaddi* series represents the Plioceme; and if according to the higher figure of percentage, the *Yenangyoungian* had to be considered as *Pliocene,* it would necessarily represent the lower Pliocene while the *Irrawaddi* series would represent the upper Pliocene, an assumption which would mean a stratigraphical impossibility. This view, of separating the *Yenangyoungian* from the *Promeian* and uniting it with the *Irrawaddi* series, or to consider the whole of the *Pegu* Division as the lower part of the *Irrawaddi* series, would be so directly in opposition to the natural sub-division of the Tertiary system in Burma that it would be absurd to adopt it solely on the strength of figures of very problematical value.

Notwithstanding the high percentage of "recent" species in the meaning of Deshayes, of 48·6 °/₀ or in my more restricted meaning, of neogene species with 30 °/₀, we cannot attribute any other but Miocene age to the *Yenangyoungian,* and have therefore to consider the *Yenangyoungian* as upper and the *Promeian* as lower Miocene. Inversely we can conclude that in India and Burma the Miocene has a higher percentage of neogene or recent species than in Europe.

Such a view was, if I am not mistaken, first hinted at by Jenkins [1] with regard to the Miocene of Java, and Professor Martin [2] has come from a purely hypothetical point of view to the same conclusion, which he expresses in the following words: "dass bei relativ gleichaltrigen Schichten Indien's einerseits Europas anderseits, wir einen bei Weitem höheren Procentsatz recenter Arten im indischen Tertiär antreffen werden, als im europæischen; and zwar muss der Unterschied grösser werden, je jünger die Schichten sind, welche gleichzeitig hier wie dort abgesetzt wurden."

The average percentage of mollusca, and only these classes should be taken into consideration, when compared with Deshayes' figures, which Professor Martin

[1] Quart. Journal Geolog. Society of London, 1864, Vol. XX, page 63.
[2] Die Tertiärschichten auf Java, General part, page 34.

states the Miocene of Java has in common with the Indian Ocean is 33·5°/₀, but he thinks that for various reasons this percentage ought to be higher, *viz.*, 50°/₀. Though apparently obtained by a somewhat different reasoning, Professor Martin's figures agree so well with those obtained by me, that the similarity is really striking. I calculated the number of neogene species to be 30°/₀ of the total, but when the Pacific types are included, this figure rises to 48·6°/₀.

Similar figures, obtained by different authors at different times, must certainly possess a great degree of probability, and we can therefore conclude that Deshayes' figures do not hold good for the Tertiary system in tropical countries. A new standard will have to be established, and for the Miocene of India, Burma and Java, we may assume that the proportion is 30°/₀ of neogene species or about 50°/₀ when all recent species, irrespective of their present habitat are included.

7.—Summary.

The main facts arrived at in the foregoing chapters can briefly be summarized as follows:—

(1) The vertical range of the fossils is a very short one; only 16 species occurring in more than four horizons, the vast majority being restricted to one or two horizons only.

(2) The fauna is composed of two classes of types, which may be called *Palæogene* and *Neogene* species, the former representing all such which have no connection with species occurring at present in the Indian Ocean, the latter having relatives among that fauna. If only the mollusca are considered, the *Palæogene* species represent 70°/₀, the *Neogene* species 30°/₀.

(3) The *Palæogene* species are composed of four different groups, *viz.*, Indigenous types, 36·2 °/₀, Gallic types, 13·8°/₀, Pacific types, 18·6 °/₀, and Mediterranean types, 1·2°/₀ of the total molluscan fauna.

(4) The *Neogene* species are composed of three different groups, *viz.*, identical species, 11·4°/₀, sub-identical species, 11·4°/₀, evolutionary species, 4·8°/₀ of the total molluscan fauna.

(5) The percentage of each of these seven groups varies considerably in the fauna of the different horizons, but if taken as the whole of *Palæogene* and *Neogene* species it remains fairly constant throughout the series.

(6) The fauna is almost exclusively composed of Pelecypoda and Gastropoda, amounting to 86·88 °/₀ of the total of known species.

(7) The fauna of the *Yenangyoungian* is purely marine and indicates a littoral facies, probably not existing in a greater depth than 25 metre. Locally it is estuarine.

(8) The fauna of the *Promeian* contains a curious mixture of marine and terrestric animals towards its top, but the *Promeian* as a whole is most probably of Estuarine origin.

(9) There is not a single species in common with the Miocene of Europe.

(10) The fauna of the *Yenangyoungian* contains 20 species, most of which are

Gastropoda, in common with the *Gajian* of Western India, though this figure is probably smaller than its true amount.

(11) The fauna of the *Yenangyoungian* contains 27 species, most of which are Gastropoda, in common with the Miocene of Java.

(12) Except perhaps one or two, none of these 47 species ranges from Java to Western India.

(13) There are indications that the Miocene of Java and the *Gajian* of Western India have a common coralline facies which is either not developed in Burma or has not been discovered yet.

(14) The Deshayes-Lyell figures for the determination of the age of the Tertiary beds do not apply for India-Burma, the figures being most decidedly higher and are for the Miocene 30 % of recent species still occurring in the same region, or 50 % if those extinct among the fauna of the Indian Ocean but occurring elsewhere in a recent state are included (Neogene + Pacific + Mediterranean types).

(15) A migration of species from West towards East commenced with the Eocene, and lasted up to quite recent times. This migration accounts for the relationship the fauna of the *Yenangyoungian* shows on one side with the Eocene of France and on the other with the recent fauna of the Western Pacific. It also accounts for the relationship of the fauna of the Miocene of Europe with that of the Indian Ocean. Jenkins' hypothesis has been confirmed, but the results arrived at from the examination of the fauna *Yenangyoungian* are in direct opposition to Sempers' theory.

(16) It seems that the Pelecypoda chiefly represented the migratory element, while the Gastropoda remained more stationary.

(17) The fauna of the Miocene of Burma contains 30 % of species which are direct ancestors of such living at present in the Indian Ocean.

(18) The fauna of the Indian Ocean, though in part descended from the local Miocene fauna, contains a foreign, probably European, element of Miocene origin.

(19) The *Yenangyoungian* must be considered as equivalent to the Miocene of Europe, though its percentage of recent species is considerably higher than that of the Miocene of Europe and corresponds about to that of the European Pliocene.

(20) The history of the Miocene of Burma which has been revealed by grouping the observations and facts can be sketched as follows:

During the Eocene period a shallow sea existed in Burma; this sea was gradually filled up by the detritus of large rivers, which also carried a large quantity of vegetabilic and animal matter seawards; the latter gave birth to the coal seams and petroleum deposits we now find in the *Promeian*. Towards the end of the *Promeian* a probably rapid subsidence took place, which was not perhaps without influence on the previously deposited strata. A marine fauna made its appearance, yet the transport of terrestric remains did not quite stop, but it finally ceases with the termination of the *Promeian*, and a shallow sea in which a rich fauna thrives extends all over Burma. But it is an area of subsidence; a fauna exists only for a short time at a certain place; it soon dies out and is replaced by

another fauna, which hardly has any species in common with the older one. Contemporaneously with these marine beds, estuarine deposits were formed probably indicating the mouths of large rivers. The fauna, as a whole, was in a state of transformation by which the Pelecypoda were chiefly affected; towards the end of the *Yenangyoungian* probably an increased influx of sweet water took place. The marine fauna disappears; at a few localities it still survives in the shape of oyster banks, but these disappear too, and estuarine beds apparently conclude the Miocene throughout Burma. We cannot exactly state when this period terminated; because it is evident that at least in upper Burma part of it has been eroded. After the termination of the Miocene, a large part of the *Yenangyoungian* was denuded, previous to the deposit of that vast thickness of strata, known as Siwaliks in India or *Irrawaddi* series in Burma.

We are unable to say what became of the marine fauna during the deposit of the *Irrawaddi* series, because no marine equivalents of this series are known. We can, however, positively say, that while the remarkable terrestric fauna contained in these beds made its appearance, lived, died out and was replaced by a perfectly different one, the marine fauna underwent a small change only; some of its types died out, others migrated in Eastern direction, while a foreign element coming from West filled up their places, but a considerable percentage of species persisted and the descendants still live in the same region where the ancestors are buried in the Miocene beds.

DESCRIPTIVE PART.

I. COELENTERATA.

Class: ANTHOZOA.

Sub-class: HEXACORALLA, Haeckel.

Order: MADREPORARIA, Milne Edwards.

Family: *TURBINOLIDAE*, E. H.

Genus: CERATOTROCHUS, Milne Edwards and Haime.

CERATOTROCHUS ALCOCKIANUS, spec. nov., Pl. I, figs. 1, 1*a*, 1*b*.

The corallum is simple, free, conical and slightly recurved towards its basis.

The calice is oval, but the two axes differ very slightly in length; the fossula is broad but not very deep.

Collumella and pali not observed, though it is unquestionable that they exist.

The septa are rather thin, those of the first three cycles being much larger than the others, upper edge sharp, sides covered with numerous fine granulations.

The costæ are rather strongly developed, simple, covered with sharp granulations and separated by broad concave intercostal incisions.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.

Zone of *Cytherea erycina*, Kama.

Remarks.—I have not been able to discover any living relative among the fauna of the Indian Ocean, neither is there any similar species known from the Miocene of Western India. It seems, therefore, that *Ceratotrochus alcockianus* represents an extinct type, though this question can only be definitely decided when the Anthozoa of the Indian Ocean are better known.

Genus: FLABELLUM, Lesson.

FLABELLUM DISTINCTUM, Milne Edwards, Pl. I, figs. 2, 2*a*, 3, 4, 4*a*.

1879-80. *Flabellum distinctum*, K. Martin, Tertiärschichten auf Java, p. 134, pl. XXIV, figs. 5, 6, 7, 8.

Corallum simple, cuneiform, rather short and much compressed, particularly towards the base, peduncle not observed, lateral edges straight, forming an angle of about 60° in the smaller specimens, while in the largest it is rather over 90°. All the costæ simple, flatly rounded, rather strong and crossed by ill-developed longitudinal sulci which correspond to the outer edge of the septae, sharply engraved.

The calice is longitudinally elliptical, the longer axis being in lateral direction; the proportion of the two axes, the shorter one being taken as 1, is almost 1 : 3. The fossula is long, narrow and deep.

Columella ill seen, but apparently formed by short, thick trabiculae.

The septa are distinctly bifoliate, but they are ill seen, and it cannot be stated how many cycles are formed; according to Milne Edwards the septa of the first three cycles are of the same size, and we must assume that those appearing on the cross-section represent the first three cycles, minor septa ill seen. The septa are rather thin, closely set, their upper edge being strongly curved, their surface is curved with short spines of different sizes, arranged rather irregularly in rows, approximately parallel to the edge.

Geological occurrence.—

Zone of ***Parallelipipedum prototortuosum***, Kama.
Zone of ***Pholas orientalis***, Thayetmyo.
Zone of ***Cytherea erycina***, Prome.

Remarks.—There seems to be no doubt that the specimens here described are identical with ***Flabellum distinctum*** mentioned by K. Martin from Java, a species which is most probably identical with ***Flabellum stonesi***, Duncan, from the Indian Ocean.

Genus: PARACYATHUS, Milne Edwards and Haime.

PARACYATHUS CAERULEUS, Duncan, Pl. I, figs. 5 *a-d*, 6, 6*a*.

1889. *Paracyathus caeruleus*, Duncan, On the Madreporia of the Mergui Archipelago, Journal of the Linnean Soc. Zoology, Vol. XXI, p. 5, pl. I, figs. 10—11.

1895. „ „ Noetling, Miocene Foss., Upper Burma, Mem. Geolog. Survey of India, Vol. XXVII, Pt. 1, p. 6, pl. I, figs. 1, 1*a*, 1*b*, 1*c*, 2, 2*a*.

The corallum is generally of small size, measuring in the average hardly more than 10 mm. in height, though larger specimens frequently occur; it is cup-like in shape having rather a broad base and a conical stem which is strongly restricted just above the base.

The walls appear smooth, particularly when the costæ are worn off; the latter are very narrow, closely set and covered with fine granulations.

The calice is elliptical in shape, rather shallow, the lateral axis slightly longer than the other one.

The septæ form five incomplete cycles, those of the first two being considerably larger than those of the three remaining ones; they are rather thick, their upper edge curved and sharp, those of the first two cycles rising considerably above the mural epitheca, their sides are set with numerous fine granulations. Neither columella nor pali visible.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Meiocardia metavulgaris*, Singu.
Zone of *Cancellaria martiniana*, Minbu.
Zone of *Arca theobaldi*, Kama.
Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—Having been able to compare Professor Duncan's type specimens, I could say in my previous memoir that there is not the slightest difference between the fossil and recent specimens, a view which is unfortunately not supported by the figures. The great difference existing between figure 2*a* and figure 1*a*, the recent and the fossil specimen, is too glaring, and it might puzzle anybody why I identified two so unmistakably different species. This dissimilarity does, however, not exist, and is simply due to an inexperienced native draftsman, the two figures being drawn by different men, and when the error was discovered, it was too late to have it corrected. Figures 1 and 1*a* are, however, correct; in figure 2*b* no notice is taken of the difference in the strength of the septæ, those of the 1st and 2nd cycle being made equal to those of the other cycles; on the other hand the thickness of the septæ of figure 1*b*, but particularly of figure 1*c*, has been greatly exaggerated, as will be seen by comparison with figures 1*a* and 1*c*.

Family: *EUPSAMMIDÆ*, Milne Edwards and Haime.

Genus: EUPSAMMIA, Milne Edwards and Haime.

Eupsammia regalis, Alcock, Pl. I, figs. 7, 7*a*.

1893. *Eupsammia regalis*, Alcock, Journ. Asiatic Soc. of Bengal, Vol. LXII, Pt. 2, p. 144, pl. V, figs. 8, 8*a*.
1895. „ „ Noetling, Miocene Foss., Upper Burma, Mem. Geolog. Survey of India, Vol. XXVII, Pt. 1, p. 6, pl. I, figs. 3, 3*a*.

The corallum is simple, free, oval, sometimes slightly compressed.

The calice is oval and rather deep.

The septa are rather thin, closely set and covered with very fine granulations.

The costæ are on the majority simple, but sometimes one or the other subdivides in two or three branches; they are slightly undulating, subequal, finely granulose, and united at regular intervals across the deep, intercostal incissions by horizontal spicules.

Geological occurrence.—

Zone of *Paracyathus caeruleus*, Yenangyat.

Remarks.—The specimens which have come under examination are all in a more or less fragmentary state of preservation. I have, however, convinced myself by comparing them with Major Alcock's type specimen that the sculpture of the costæ is exactly the same in both the living and fossil specimens.

II. ECHINODERMATA.

Class: ECHINOIDEA.

Sub-class: EUECHINOIDEA, Bronn.

1. Order: REGULARES, Desor.

Family: *CIDARIDÆ*, Wright.

Genus: CIDARIS, Klein.

CIDARIS, spec. 1, pl. I, figs. 8, 8*a*, 9, 9*a*, 10.

A number of detached spines have come under examination which may probably belong to one and the same species, notwithstanding their great variability. All have one feature in common, that is the shaft is more or less inflated in the region of the lower third, producing a subfusiform profile; the distal extremity is almost always flaring and cup-shaped. The ornamentation is more or less spinulose and always much stronger on one side of the shaft than on the other. Figs. 8, 8*a* represent a spine of 52·8 mm. in length; the shaft is fusiform, slightly broader on the lower third than at either end. The distal end is broadly expanded, but obliquely truncated, and set with a crown of laterally compressed lamellæ, which are stronger on the side opposite to that which bears the stronger tubercles. The shaft is set with tubercles which are arranged in longitudinal, though somewhat irregular rows, their interstices being occupied by very fine granulations. On one side the tubercles are small and low near the proximal end, but quickly assume the shape of strongly raised, laterally compressed spines. On the opposite side the tubercles remain low and rounded throughout the length of the shaft.

Figs. 9, 9*a* are 36·5 mm. in length, neatly shaped like a cigar-holder, and considerably broader at the proximal, than at the distal, extremity. The distal end is obliquely truncated and slightly expanded; the cross-section of the shaft is elliptical but unsymmetrical, one side being stronger curved than the other. The ornamentation consists of tubercles arranged in longitudinal rows; on the flatter side these tubercles are rather small and remain so throughout the whole length of the shaft, while on the opposite side they are much stronger, increasing in strength towards the distal end.

Fig. 10 represents a small club-shaped spine of about 14 mm. in length, having a circular cross-section and being much thicker in the middle than at either end; the surface is smooth and free of any tubercles, except at the distal end which is truncated and set with a crown of short lamellar tubercles.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.
Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—I fully agree with Professor Duncan that it would be little more than frivolity and guess-work to assign specific names to detached spines, knowing that they vary both in shape and character on different parts of the same test; on the other hand it is certain that the spines here described harmonise with some specimens figured by Professor Duncan; fig. 8 is unquestionably identical with the spine pl. XLV, fig. 25, while fig. 9 probably represents the same as fig. 22. Though therefore no specific name can be given, it is certain that the same species of *Cidaris* or *Phyllacanthus* occurs in the Miocene of Burma and the Gajian of Western India.

CIDARIS, spec. 2, Pl. I, fig. 12, *a-b*.

The spines are of small size only, rather slender, having an angular cross-section, one side being stronger, curved and having a longitudinal keel in the middle, while the opposite side is flat without a keel. Both sides are perfectly smooth and without even very fine granulations. The head is well set off, conical and notched.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Remarks.—Though I refrain from assigning a specific name to these spines, it is quite evident that they belonged to a species perfectly different from *Cidaris*, spec. 1, and they may perhaps belong to the same species as figured by Professor Duncan on pl. XLV, fig 18.

2. Order: IRREGULARES, Desor.

Sub-order: GNATHOSTOMATA.

Family: *CLYPEASTRIDÆ*, Agassiz.

Genus: CLYPEASTER, Lamarck.

CLYPEASTER DUNCANIANUS, spec. nov., Pl. I, fig 13.

Marginal contour sub-pentagonal, the angles being flatly rounded, much broader between the anterior than between the posterior angles, the greatest breadth being just in front of the antero-lateral petals. The length is greater than the breadth, but owing to the fragmentary state of the specimen no accurate measurements could be taken. The lateral sides are straight and converge in posterior direction, the posterior side being apparently slightly incurved in the centre.

The general form is flat and strongly depressed, the margins thin and the abactinal surface sloping from the very slightly elevated apex at a low angle of declivity. The profile line is very slightly concave and the apex feebly conical.

Apical disc not observed.

The ambulacral petals extend slightly beyond the middle, between apex and ambitus; they are rather broad, petaloid and fairly straight. The anterior petal appears to be a little longer, but narrower than the paired ones. The poriferous

zones are very wide, but slightly narrower than the interporiferous one, and the breadth increases from the apex almost close towards the end when it suddenly decreases, to form the rounding of the petal. Both inner and outer pores are of the same size, oval in shape, the pairs being united by a very faint conjugating furrow. The costæ between each successive pair are very low and apparently set with a few indistinct tubercles.

The interambulacral areas are subcarinate in the inner part of the abactinal surface, their ornamentation consists apparently of numerous small scrobiculated tubercles.

Abactinal surface, peristome and periproct not observed.

Geological occurrence.—

Unknown horizon near Prome.

Remarks.—Only a single specimen, in rather a fragmentary state of preservation, has come under examination, but it has been possible to make out its features sufficiently well to prove it to be a different species from all those which have been described by Professor Duncan from Western India.

The strongly depressed shape of the test proves at once that it cannot be related to highly conical species like *Clypeaster profundus*, d' Archiac; and it exceeds all the compressed species described by the same author, by its size, its length having probably been not much under 100 mm., while the largest specimen of *Clypeaster complanatus*, Duncan and Sladen, measures 79 mm.

A much more important feature is, however, the difference of shape; the marginal contour of *Clypeaster duncanianus* is evidently a pentagon, having a very small base, and its greatest breadth between the two anterior angles. None of the species described by Professor Duncan exhibits this shape, all of them having rather a broad base. Another peculiarity of *Clypeaster duncanianus* are the ambulacra; though very much in shape like those of *Clypeaster complanatus*, Dunc., they are composed of poriferous zones, the pores of which are oval in shape, a feature which is most probably not due to weathering. In *Clypeaster complanatus*, as well as *Clypeaster depressus*, the inner pores are round and the outer ones oval.

III. MOLLUSCA.

1. Class: PELECYPODA, Goldfuss.

Family: *OSTREIDÆ*, Lamarck.

Genus: OSTREA, Linné.

The description of the undermentioned species may appear somewhat peculiar, because it differs from the traditional style, by adopting a different position of the shell which is in fact turned over by 90° to the right; since Jackson[1] has proved that the traditional terminology of *Ostrea* is not in harmony with the position of the animal in the shell, it would appear illogical to stick to the old terminology. I

[1] Mem. of the Boston Soc. of Nat. History, Vol. IV, page 309.

have, therefore, applied the terms ventral and posterior margin to those parts of the shell which correspond to the respective sides of the animal.

Four species have been described, but three only could be accurately determined, while the specific independence of the fourth seems somewhat questionable. These species can be distinguished as follows :—

A. Both valves covered with angular ribs.

1. *Ostrea peguensis*, spec. nov.

B. Left valve covered with rounded ribs, right valve smooth.

(*a*) Ribs moderatly strong, shell not very much inflated.

2. *Ostrea promensis*, spec. nov.

(*b*) Ribs thick, shell strongly inflated.

3. *Ostrea promensis*, spec. nov. var.

C. Both valves smooth.

4. *Ostrea papyracea*, spec. nov.

The most remarkable feature of these three species is, that none of them has any living relative among the present fauna of the Indian Ocean. Though I have carefully studied the recent species in the collection of the Indian Museum, not a single one shows even a distant relationship with the species here described. On the other hand *Ostrea promensis*, spec. nov., has its nearest relatives in *Ostrea blanfordiana*, spec. nov., from the Eocene of Western India and *Ostrea multicostata*, Des., or *Ostrea flabellula*, Lam., from the Eocene of Paris; *Ostrea papyracea* has probably its nearest relative among the smooth-valved species of the Paris Eocene, while no relationship whatsoever could be discovered of *Ostrea peguensis*, spec. nov., which most probably has its nearest relations in the Eocene of India.

These observations seem to prove that the *Ostreae* of the Miocene of Burma are the last descendants of an old stock, widely distributed during Eocene times, and that the *Ostreae* living at present in the Indian Ocean represent a perfectly new element which has quite recently migrated into its present habitat from unknown parts of the globe.

OSTREA PEGUENSIS, spec. nov., Pl. II., figs. 1, 1*a*, 2, *a*-*b*.

MEASUREMENTS.

Length.	Height.
96 mm.	85 mm.

The shell is irregular in shape, but generally more or less orbicular, length and height being very much the same; it is extremely inequilateral, but only slightly inequivalve.

(*a*) *Left valve.*—The left valve is more or less orbicular, the length generally exceeding somewhat the height; at both ends it is broadly expanded, perhaps slightly attenuated at the anterior extremity. It is always very flat, though the surface is rather uneven.

The umbo is low, not pointed and terminal, coinciding with the anterior margin; the pedal region is therefore small, rudimentary, the siphonal region large and broadly expanded.

The anterior margin is entirely submerged into the ventral margin, which is oblique and of moderate length, but somewhat irregular; the posterior margin is very long, almost circular; its ventral portion is broadly rounded and apparently larger than the convex, dorsal portion which is strongly, though somewhat irregularly, inclined in anterior direction. The cardinal margin is rather small.

The ornamentation consists of a dozen, or even less, very irregular ribs radiating from the umbo; originally the ribs are rather high, sharp and roof-like, separated by deep, broad interstices. The continuity 'the ribs is, however, frequently interrupted by coarse, irregular, concentric st of growth.

The scar of attachment is exceeding.j small and the shell must have become free at a very early stage.

The cartilage groove is large and broad, but apparently rather shallow.

The muscular scar is comparatively small, slightly dorsal of the antero-posterior axis. In the larger part of the shell the test is rather thin, being 3 mm. and under in thickness, but towards the margins, particularly towards the ventral portion of the posterior margin, it thickens considerably, attaining a thickness of 20 to 25 mm.

(*b*) *Right valve.*—The right valve is in shape exactly the counterpart of the left one, but it appears to be somewhat flatter and apparently the ribs were less strongly developed than on the left valve.

Geological occurrence.—

Zone of *Ostrea peguensis*, Prome district.

Remarks.—The exact horizon of this species is not known; the rock still attached to the specimens differs, however, from that of the bed in which *Ostrea promensis* occurs; it is therefore very probable that this species forms a bed in which all other species are excluded, though nothing can be said with regard to the position it holds in the sequence of the strata.

Ostrea peguensis is easily distinguished from all the others by its large, rather flat shell, both valves of which are covered with coarse high roof-like ribs.

No similar species has been described from either Western India or from Java or Sumatra, and among the European Tertiary species I cannot find any species exhibiting similar characters, except perhaps *Ostrea crassicosta*, Sow., which is, however, distinctly different.

Among the living species *Ostrea sinensis*, Reeve, and *Ostrea turbinata*, Reeve, which is probably only a stronger ribbed variety of the former, appear to be closely related to this species; it must, however, be mentioned that in both species the high sharp ribs appear only towards the margin, while the larger part of the shell is destitute of ribs and covered with lamellar concentric striæ of growth only. It is therefore not very probable that either of this species stands in any evolutionary relationship to *Ostrea peguensis*, because this species is covered with ribs extending from the umbo to the margin.

We must therefore suppose that *Ostrea peguensis* is an extinct type among the present fauna of the Indian Ocean, and as no similar species is known from the Eocene beds of Europe, it probably represents an indigenous type.

OSTREA PROMENSIS, spec. nov., Pl. II, fig. 3, *a-b*, Pl. III, figs. 1, *a-b*, 2, *a-b*.

MEASUREMENTS.

	Length.	Height.
Left valve	87 mm.	76 mm.

The shell is irregular in shape, but generally considerably longer than high, extremely inequilateral and inequivalve.

(*a*) *Left valve.*—The left valve is etimes irregularly orbicular, sometimes irregularly triangular in shape; in the ..ter case it is attenuated at the anterior, and broadly expanded at the posterior region. In some instances it is very flat, in others moderately inflated; the scar of attachment is usually large in the former, and small in the second case, so that it is evidently proved that the inflation depends chiefly on the degree to which the shell is attached.

If well developed, the umbo is pointed, strongly advanced in anterior direction, and coinciding with the anterior margin; the pedal region is therefore rudimentary while the siphonal region is large and broadly expanded.

The anterior margin cannot be distinguished as such, is very rudimentary and probably entirely merged into the ventral margin; the latter is moderately long, oblique, sometimes slightly concave; the posterior margin is extremely long, almost circular, irregularly curved, its ventral portion is broadly rounded, forming a very obtuse angle with the ventral margin; the dorsal portion is rather long, sometimes straight, sometimes slightly convex, but generally inclined in anterior direction; the cardinal margin is small. The ornamentation consists of numerous moderately strong, irregular ribs, radiating from the umbo all over the surface. The ribs are rounded, of almost the same strength, separated by interstices of the same breadth and increasing in number by bifurcation; they are crossed by numerous irregular striæ of growth, becoming thus rather scaly.

The cartilage groove is short, bordered on either side by a strong ridge, and turned in dorsal direction.

(*b*) *Right valve.*—The right valve is apparently slightly smaller than the left one; its general outline, irregularly orbicular or triangular, is much the same as that of the left valve; it seems, however, that the triangular shape is more frequent, and in this case it is strongly attenuated anteriorly, and broadly expanded posteriorly. It is mostly flat, but there are instances in which it is strongly inflated all over the surface, or others where it is inflated at the umbonal region, and flat or almost concave afterwards.

The umbo is low, pointed, terminal; pedal region rudimentary, siphonal region large and broadly expanded.

Margins generally the same as in the left valve.

The surface is destitute of radiating ribs, and compared with the left valve it appears smooth; it is, however, covered with numerous, concentric, rather regular striæ of growth, which give it a peculiar lamellar appearance. Cartilage groove as in the left valve.

Both valves have a rather thick test up to 10 mm. and more in thickness.

Geological occurrence.—

Zone of *Ostrea promensis*, Prome district.

Remarks.—The geological horizon of this species is not known with certainty, but it appears that it occurs in a bed entirely composed of its shells with the exclusion of all other species, but until further researches have been carried out the question of the geological horizon of *Ostrea promensis* must therefore remain in abeyance.

Messrs. d'Archiac and Haime have described under the name of *Ostrea multicostata*, Desh. var., a species which at the first glance bears a great similarity to *Ostrea promensis*. On further examination there will, however, be seen that a considerable difference exists with regard to shape and ornamentation of both species; *Ostrea multicostata*, d'Arch. and Haime (non Deshayes!), is more elongate in shape, while *Ostrea promensis* is orbicular. The ribs of the former species are always more slender than those of the latter, but the chief difference consists in the disproportion of the size of the right and left valve in *Ostrea multicostata*, d'Arch. and Haime, while both valves are of almost the same size in *Ostrea promensis*.

It is to be regretted that Messrs. d'Archiac and Haime apparently overlooked this feature, which gives their *Ostrea multicostata* such a peculiar appearance; the left valve is very large, but the visceral chamber is very small and covered by a small right valve only, which leaves a good deal of the left valve free, surrounding the right valve in the shape of a broad rim.

To me it seems therefore unquestionable that *Ostrea multicostata*, d'Archiac and Haime, cannot be identified with *Ostrea multicostata*, Deshayes, and it appears that the authors themselves had some doubts as to the correctness of their view by adding *var.* to their determination. The specific name of "*multicostata*" of Messrs. d'Archiac and Haime's *Ostrea* will have therefore to be changed. That *Ostrea multicostata*, d'Archiac and Haime, is really different from Deshayes' species of the same name has already been noticed by Dr. Blandford[1] and Mr. Oldham.[2] I propose therefore the name of *Ostrea blandfordiana* for this characteristic species from Sind.

No similar species is known from either Java or Sumatra.

I cannot find any living relative, although there are two species, *Ostrea auriculata*, Reeve, and *Ostrea multicostata*, Reeve, from Japan which by their costated left valve resemble in a general sense of view to *Ostrea promensis*, but as both species have also a ribbed right valve, any identity is of course out of question.[3]

On the other hand it cannot be denied that *Ostrea promensis* bears a great similarity to species like *Ostrea prona*, S. Wood, or *Ostrea flabellula*, Lamarck, the latter species being particularly characterized by a right valve which is slightly smaller than the left one.

Though *Ostrea promensis* represents therefore a type which is extinct among

[1] Geology of Western Sind, Mem. Geol. Survey of India, Vol. XVII, pt. 1.

[2] Manual of the Geology of India, 2nd edition, page 318.

[3] The specific names of both the species must be changed, because in 1832 Defrance described an *Ostrea auriculata* from the Cenomanian and in 1837 Deshayes an *Ostrea multicostata* from the Tertiary of France, while Reeve's names date from 1871.

the fauna of the Indian Ocean, it is unquestionable that its nearest relatives occur in the Eocene of Europe.

OSTREA PROMENIS, spec. nov. var.

There are three ill-preserved fragments of an *Ostrea* which, by their general habitus, appear to be closely related to *Ostrea promensis*; some differences seem, however, to exist which compelled me to separate it.

It appears that the left valve of this species was stronger inflated and the ribs coarser and thicker; as all the three specimens come from a bed which contains numerous other fossils though none of them could unfortunately be determined specifically, it is very probable that they are not derived from the same bed as *Ostrea promensis*, and represent perhaps a different species.

Geological occurrence.—

Unknown horizon, Thayetmyo district.

OSTREA PAPYRACEA, spec. nov., Pl. III, figs. 3, *a-b*, 4, *a-b*, 5, *a-b*, 6, *a-b*, 7, *a-b*.

The shell attains only a small size, and appears to be very irregular in shape of both valves; it is, however, always longer than high, more or less attenuated towards the anterior extremity, inequilateral and sub-equivalve.

(*a*) *Left valve.*—The left valve is generally more or less trigonal in shape, attenuated at the anterior and slightly expanded at the posterior extremity, and it appears always moderately inflated. The scar of attachment is very small and hardly visible.

The terminal umbo shows varying degrees of pointedness, the pedal region is rudimentary, the siphonal region elongate and broad.

The margins do not seem to retain any special direction, but they are curved in various degrees. There is no ornamentation except numerous concentric striæ of growth.

The cartilage groove is very small and flat.

Muscular scar small.

(*b*) *Right valve.*—The right valve is similar in shape to that of the left one, but it appears that it exhibits a larger variation with regard to inflatedness. Some valves are quite as much inflated as left valves, others are perfectly flat. Otherwise it is much the same as the left valve.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—It will be seen from the above description that this species exhibits very few characteristic features; in fact, its chief characters are an irregularly elongate shell, both valves of which are smooth, with the exception of fine concentric striæ of growth. These characters are, however, sufficient to distinguish *Ostrea papyracea* from all the others here described, although it may be argued that the distinction between isolated right valves of *Ostrea promensis* and *Ostrea*

papyracea is by no means easy. As it is, however, very probable that both species characterise different horizons, a confusion does not seem to be likely.

Ostrea incisa, Martin, from the Miocene of Java, is probably a near relative, but this species is easly distinguished by the crenulated margins.

No similar species is hitherto known from Western India.

I cannot discover any living relative among the fauna of the Indian Ocean and we must therefore suppose that it represents an extinct type, the nearest reatives of which are probably found in the Eocene of Paris, though for want of specimens for comparison I refrain from naming a species to which it might be related.

Family: *SPONDYLIDÆ*, Gray.

Genus: SPONDYLUS, Linné.

SPONDYLUS, SP.

It is remarkable that this genus which in other Tertiary strata exhibits numerons and fine species is in the Burma Miocene represented by a single species only, of which only a solitary ill-preserved right valve has come under examination.

It measures about 25 mm. in height, while its length was apparently smaller; the index is therefore smaller than 1; it is moderately, though irregularly, inflated and irregularly elliptical in circumference. The surface is covered with numerous fine flat radiating ribs which become rather irregular by a few strong concentric wrinkles.

Geological occurrence.—

Zone of *Aricia humerosa*, Thayetmyo.

*Remarks.—*It would be rather rash to form any conclusion as to the specific identity of this species as all the more essential features ar emissing. I therefore refrain from expressing an opinion, although I may safely say that the species here mentioned was certainly different from any *Spondylus* described by Messrs. d'Archiac and Haime or Professor Martin. It may, however, be possible that it is closely related if not identical to *Spondylus minor*, A. Böhm, from Madura.

Family: *LIMIDÆ*, d'Orbigny.

Genus: LIMA, Brugière.

Two species only which represent too widely different types have been found; they may be easily distinguished as follows:—

A. Surface smooth.

1. *Lima griesbachiana*, spec. nov.

B. Surface covered with squamose ribs.

2. *Lima protosquamosa*, spec. nov.

The smooth *Lima griesbachiana* has no living relative among the fauna of the Indian Ocean, neither has any fossil relative been discovered; it is therefore an extinct type which probably had its predecessor in the Eocene of India.

On the other hand has *Lima protosquamosa* its nearest relative in the living

Lima squamosa, being distinguished from that species only by a smaller size and probably a more delicate ornamentation.

LIMA GRIESBACHIANA, spec. nov., Pl. III, figs. 8, 9, *a-c*.

MEASUREMENTS.

	Length.	Height.	L/H.
1. Right valve	20·6 mm.	24·8 mm.	0·83
2. "	19·6 "	24·4 "	0·79

The shell is of small size, obliquely oval in shape, considerably higher than long; the index L/H is therefore smaller than 1, though owing to the scarcity of material at my disposal I am unable to say anything about its amplitude. It is strongly inflated, dropping perpendicularly towards the ventral side, gently in postero-dorsal direction, very inequilateral, not gaping at either the ventral or the dorsal side. There is no doubt that the ears on both the ventral and dorsal side are absent.

The umbo is strongly inflated, curved inwards, turned a little in dorsal direction and situated terminally, directly above the anterior margin.

The pedal region is very short, rudimentary; the siphonal region large, broadly expanded.

The anterior margin is very short; in fact it is entirely submerged in the long slightly convex ventral margin which takes an abrupt turn in dorsal direction. The posterior margin is very long, angularly broken; its posterior part is strongly convex and merges gradually into the ventral margin, while its anterior part is straight, forming an oblique angle with the short, straight cardinal margin.

The surface is covered with a thin, shiny epidermis, which is easily rubbed off, thus exposing the structure of the middle shell layer. The latter is composed of numerous, very fine flat radiating ribs, separated by interstices of half their breadth. On the epidermis this structure is represented by fine, engraved radiating lines corresponding to the interstices, separated by broad flat radiating bands, corresponding to the ribs. Both are crossed by fine concentric and equidistant striæ of growth, producing a kind of square ornamentation, a feature which is, however, chiefly restricted to the postero-dorsal region.

Geological occurrence.—

Zone of *Aricia humerosa*, Thayetmyo.

Remarks.—The species here described bears no similarity to any species of this genus living nowadays in the Indo-Pacific Province. According to Reeve five species inhabit the Indian Ocean, not including those living in the Red Sea; with none of those has *Lima griesbachiana* any resemblance, neither can I find any similarity with specimens from the European Tertiary formation. It seems therefore that *Lima griesbachiana* represents an extinct type which probably had its nearest relative in the Eocene of India.

LIMA PROTOSQUAMOSA, spec. nov., Pl. III, figs. 10, 10 *a*.

MEASUREMENTS.

Length.	Height.	L/H.
24·0 mm.	28·0 mm.	0·85

There is only a single right valve of this species which has come under examination, but although being ill-preserved, it shows distinctly that it belongs to a species different from the former.

The shell is of moderate size, obliquely oval, rather flat, very inequilateral and much higher than long; the index L/H is, therefore, smaller than 1. The valves were apparently slightly gaping at the dorsal side; there is a small, well set off dorsal ear, and there probably existed a rudimentary ventral one too, although this cannot be stated with certainty.

The umbo, though missing, was apparently pointed and terminal, close on the anterior margin.

The pedal region is rudimentary, the siphonal one large and broadly expanded.

The anterior margin is entirely submerged into the straight slightly oblique ventral margin which at its posterior end turns abruptly upwards and passes into the long and broadly curved posterior margin; the anterior portion of the latter is straight, strongly inclined in ventral direction. Cardinal margin short, straight, forming an obtuse angle with both ventral and posterior margin.

The ornamentation consists of 24 radiating ribs of moderate strength, separated by interstices of about the same breadth.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.

Remarks.—The difference between this species and *Lima griesbachiana* need hardly be mentioned, the former having a perfectly smooth surface, while this species is provided with strong radiating ribs. Unfortunately the state of preservation does not allow to say with certainty whether the ribs were smooth or squamose. The probability is that they were squamose, and if this supposition be correct, this species would find its nearest relative in *Lima squamosa* which inhabits the Red Sea and the Indian Ocean. Owing to the insufficient state of preservation I refrain, however, from drawing further conclusions, though it is pretty certain, to judge from the general shape, that both species are closely allied, and as *Lima squamosa* has a larger size and stronger ribs, this feature would be quite in harmony with the observation made in other species, which are the ancestors of those living in the Indian Ocean.

Lima lima, Linn., which is another species inhabiting the Indian Ocean and which might also be compared, is easily distinguished by the much larger number of ribs.

Family: *PECTENIDÆ*, Lamarck.

Genus: PECTEN, Klein.

As in *Ostrea*, I differ in the terms used for the description of the shell from that adopted by previous authors, and formerly also by myself. Since Jackson has proved that the position of the animal in the shell is such, that the byssal notch is on the ventral side, the old method of description will have to be abandoned. I term therefore ventral and dorsal auricle those appendages which have been formerly termed anterior and posterior ear, and naturally the anterior margin will be termed the ventral, the ventral and posterior margins, posterior margin.

Only a small number belonging to the sub-genus *Chlamys* have come under examination; and the differences between two at least are so small, that I have some doubts whether they represent really different species, but as they occur in different beds, I have kept them separate.

The species may be distinguished in the following way :—

A. Shell large, ribs rounded, thick, 25 in number.
 1. *Pecten protosenatorius*, spec. nov.

B. Shell small, ribs rounded, fine, 26 in number, interstices punctuate.
 2. *Pecten kokenianus*, spec. nov.

C. Shell tolerably large, ribs rounded, fine, about 40 in number, interstices not punctuate.
 3. *Pecten irravadicus*, spec. nov.

It is rather difficult to trace the relationship of these three species; it seems quite certain that *Pecten protosenatorius* is the direct ancestor of the living *Pecten senatorius*, Gmel., probably representing the permanent nealogic stage, but it is much more difficult to find any relationship of *Pecten kokenianus* and *Pecten irravadicus*. Both species represent types which are extinct among the fauna of the Indian Ocean, and their nearest relatives unquestionably occur in the Eocene. It is, however, not easy to say whether such relatives occur in the Indian or European Eocene, or in both. *Pecten kokenianus* belongs unquestionably to the relationship of *Pecten reconditus*, Sol., or similar species, yet it has a very near relative in *Pecten bouei*, d'Arch. and Haime, from the Indian Eocene; the same probably applies to *Pecten irravadicus*, though no species can be named at present to which it might be related because such a question can only be settled by actual comparison.

PECTEN PROTOSENATORIUS, spec. nov., Pl. III, fig. 11, Pl. IV, fig. 1, *a-b*.

MEASUREMENTS.

Length.	Height.	L/H.
83·5 mm.	98·0 mm.	0·85

The shell is orbicular in shape, but as the height is considerably in excess of the length, the index L/H is much smaller than 1; it is apparently equivalve,

there being no difference in the ornamentation of both valves, and probably very little, or no difference with regard to the degree of inflation; both valves are very flat and inequilateral.

The umbo is small, pointed and so strongly moved in anterior direction that cardinal and ventral margin coincide, and the umbo becomes terminal.

Pedal region rudimentary, siphonal region very long, broadly expanded and rounded. Anterior margin and cardinal margin submerge into each other, forming a straight, rather short line running perpendicularly to the antero-posterior axis; ventral margin moderately long, very oblique and slightly sinuated, turning abruptly in dorsal direction at its posterior end; posterior margin very long, broadly rounded and running approximately parallel to the antero-cardinal margin, with its ventral portion, and turning abruptly in ventral direction with its posterior portion, running in a straight line towards the umbo, where the continuation of ventral and dorsal margin meet at an angle slightly under 90.°

Auricles well set off, but unequal, the ventral one is larger, elongate and deeply notched at its ventral side, its anterior and ventral margin meeting apparently at a right angle; the dorsal auricle is much shorter though somewhat longer, its anterior and dorsal margin meeting at an obtuse angle.

The ornamentation consists of about 25 strong rounded radiating ribs separated by concave interstices of slightly smaller breadth; the ribs were crossed by numerous fine, concentric lines which rendered them a little scaly; owing to the poor state of preservation this feature could only be observed in a single specimen, where it was rather effaced, ribs of the right valve interlocking with the interstices of the left; about six to seven fine ribs on the ventral auricle.

Cartilage groove small, triangular; other internal characters not observed.

Geological occurrence.—

Horizon unknown, Prome district.

Remarks.—Unfortunately no data are available as to the exact horizon of this species, but to judge from the rock in which it is imbedded, there is no question that it belongs to the Miocene series.

This species bears the greatest resemblance to *Pecten bouei*, d'Arch., its shape and ornamentation agreeing well with the figure and description as given by d'Archiac; the only difference which I could record is the size; if d'Archiac's figure is given in natural size, the specimens from Burma are unquestionably much taller, although one might not consider this feature as a specific difference. Messrs. d'Archiac and Haime give unfortunately no measurements of the specimen which served them for description, but when looking through the whole of the collection of the Sind Tertiary fossils I did not find a single specimen which came in size anywhere near to *Pecten protosenatorius*, though there were numbers which most probably represented *Pecten bouei*. In order not to introduce further confusion, as the question of identity can only be settled after a diligent examination of the Indian Tertiary fauna has been undertaken, I prefer to give

a new name to the species from Burma, which if necessary can be cancelled afterwards.

The nearest relative among the living species is unquestionably *Pecten senatorius*, Gmelin, from the Indian Ocean; in fact, the relationship seems to be so close that I am not quite sure whether *Pecten protosenatorius* should not be identified with that species; the ribs of *Pecten senatorius* show, however, a peculiar formation which could not be observed with certainty in the fossil *Pecten protosenatorius*; during the nealogic stage of *Pecten senatorius* its ribs are simple; but after it has attained a certain size, a sharp furrow appears on either flank of each rib, thus setting, though not splitting off, a secondary rib on either side; this feature increases with advancing size, and in full grown specimens each rib presents a peculiar tripartite section.

Now some of the fossil specimens seem to exhibit a similar feature towards the ventral margin, that is to say, at considerable later stage, but as already stated the state of preservation is not such as to decide with certainty about this feature; if my surmise be correct the fossil specimens from Burma should be considered as identical with the living *Pecten senatorius*, Gmel. In the meantime I am, however, certainly not mistaken if I consider *Pecten protosenatorius* from Burma as the direct ancestor of the recent *Pecten senatorius*, the latter having probably developed from the former.

Pecten kokenianus, spec. nov., Pl. IV, figs. 2, 2*a*, 3, *a-c*, 4, 4*a*, 5, *a-c*, 6, 6*a*.

Measurements.

(*a*.) Right valve.

	Length.	Height.	L/H.
1.	27·7 mm.	27·3 mm.	1·01
2.	2·66 ,,	24·0 ,,	1·10
3.	26·4 ,,	24·8 ,,	1·01
4.	26·0 ,,	23·7 ,,	1·09
5.	25·2 ,,	24·3 ,,	1·05
6.	25·1 ,,	22·2 ,,	1·13
7.	24·3 ,,	23·3 ,,	1·04
8.	23·6 ,,	21·8 ,,	1·08
9.	18·1 ,,	16·1 ,,	1·12
10.	18·0 ,,	16·9 ,,	1·06
11.	17·8 ,,	16·4 ,,	1·08
12.	1·69 ,,	15·2 ,,	1·11
13.	14·9 ,,	13·7 ,,	1·08
14.	14·0 ,,	12·5 ,,	1·12
15.	10·6 ,,	9·8 ,,	1·08

(*b*.) Left valve.

	Length.	Height.	L/H.
1.	29·0 mm.	28·1 mm.	1·03
2.	26·5 ,,	23·5 ,,	1·12
3.	26·6 ,,	25·2 ,,	1·05
4.	25·6 ,,	25·3 ,,	1·01
5.	24·9 ,,	24·1 ,,	1·03
6.	24·6 ,,	23·9 ,,	1·03
7.	23·9 ,,	22·7 ,,	1·06
8.	23·6 ,,	21·3 ,,	1·11

(*b*) Left valve—*continued*.

	Length.	Height.	L/H.
9.	22·9 mm.	21·4 mm.	1·07
10.	22·5 ,,	20·9 ,,	1·07
11.	22·5 ,,	20·0 ,,	1·12
12.	22·3 ,,	20·2 ,,	1·10
13.	21·8 ,,	20·6 ,,	1·05
14.	21·6 ,,	18·2 ,,	1·17
15.	21·2 ,,	20·0 ,,	1·06
16.	20·5 ,,	18·9 ,,	1·08
17.	20·4 ,,	18·4 ,,	1·10
18.	20·3 ,,	18·8 ,,	1·08
19.	19·6 ,,	18·0 ,,	1·09
20.	19·7 ,,	17·5 ,,	1·12
21.	19·2 ,,	18·4 ,,	1·04
22.	18·4 ,,	17·5 ,,	1·05
23.	18·3 ,,	17·2 ,,	1·06
24.	17·6 ,,	16·7 ,,	1·05
25.	16·9 ,,	15·0 ,,	1·12
26.	16·6 ,,	15·1 ,,	1·09
27.	15·4 ,,	13·4 ,,	1·14
28.	14·8 ,,	13·0 ,,	1·14
29.	14·3 ,,	13·5 ,,	1·05
30.	14·0 ,,	11·8 ,,	1·19
31.	13·7 ,,	11·5 ,,	1·19
32.	12·0 ,,	10·2 ,,	1·15
33.	11·0 ,,	9·5 ,,	1·17

The shell is, except for the differences in the shape of the ears, almost equivalve and orbicular in shape, but of small size only; the length always exceeds the height to a small extent, and though low, the index L/H never falls below 1; the amplitude of variability seems to be a small one, as will be seen from the above figures; it appears, however, that the younger specimens had a higher index, in other words are more elongate than the full grown individuals.

If arranged according to the size of index the following table is obtained :—

Index . . .	1·01	1·02	1·03	1·04	1·05	1·06	1·07	1·08	1·09	1·80	1·11	1·12
Number of specimens	2	...	3	2	7	4	2	6	3	3	2	6
Index . . .	1·3	1·14	1·15	1·16	1·17	1·18	1·19	...	...	...	...	...
Number of specimens	1	2	1	...	2	...	2	...	...	...	...	...

It will be seen that except for short gaps the chain is almost uninterrupted from 1·01 to 1·19, the mathematical average index would be 1·110, and we see that 23 specimens or 47·9 °/₀ of the total number are grouped around this index; the calculated index is, however, a little lower being 1·078, and around this figure 27 specimens or 56·4 °/₀ of the total number are gathered; it is therefore unquestionable that, if we were to exclude the few juvenile specimens with the high index, the mathematical and calculated average would almost coincide. The formula of variation should therefore be written as follows :—

$$\text{var. } 19 \begin{array}{c} 1{\cdot}19 \\ | \\ 1{\cdot}01 \end{array} \text{ average } \begin{cases} 1{\cdot}100 \text{ math.} \\ 1{\cdot}087 \text{ calc.} \end{cases}$$

There appears to be no difference worth mentioning in the index L/H of the right and left valve respectively, but for obvious reasons it will be better if the description of each valve is given separately.

(*a*) *Right valve.*—The right valve is flat, very inequilateral, attenuated at the anterior and broadly expanded at the posterior extremity; the umbo is pointed and terminal. The pedal region is rudimentary, the siphonal region large, and broadly expanded.

The anterior margin is entirely submerged into the ventral margin which is almost straight, even a little concave at its anterior part; at first it is ventrally inclined, but suddenly turns in dorsal direction to join in a broad sweep into the posterior margin, which has the same run as the ventral margin, the anterior portions of both meeting at the umbo at an angle varying from 80° to 100°.

The hinge is lodged on the inside of the auricles, the anterior margins of which fall in a straight line, forming a very pointed angle with the dorso-ventral axis.

The ventral auricle is larger than the dorsal one, and is deeply notched at its ventral side, meeting the anterior side at almost a right angle; in the dorsal auricle, dorsal and anterior side meet at a pointed angle.

The hinge consists of a long ventral lamellar tooth LAIII, having a deep socket for the insertion of a corresponding tooth in the left valve on its posterior side and a shorter dorsal tooth LPIII, separated from the former by a short triangular resilial pit.

The ornamentation consists of very regular rounded radiating ribs, separated

by interstices of the same breadth; there are 26 of them, and as the smallest and biggest specimens show the same number, it may be supposed that their number is not increased with the growth of the shell, unless by bifurcation, of which there is, however, not the slightest indication among the numerous specimens I examined. The ribs were covered with very delicate concentric lines, which become, however, easily worn off, so that in most specimens the ribs appear entirely smooth. The interstices were covered with extremely minute punctures, arranged in straight but oblique lines; this sculpture is, however, only seen under a strong magnifying lens and is easily worn off. Both auricles exhibit a few fine radiating ribs, which particularly on the ventral ear, are crossed by numerous fine concentric lines, giving them a plicate appearance.

The byssal notch is provided with a few small crenulations.

(*b*) *Left valve.*—The left valve is of the same shape as the right one, and it differs only by the shape of the auricles and the position of the cardinal lamellæ. The ventral auricle is much larger than the dorsal one; it is slightly concave and its ventral margin meets the anterior margin at a pointed angle; the dorsal auricle is much smaller, and its dorsal and anterior margin meet at an obtuse angle.

The hinge consists of two delicate, lamellar teeth, separated by the small triangular resilial pit; the ventral one, which represents LAII, is much longer than the dorsal one representing LPII.

The ornamentation is the same as that of the right valve.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.
Zone of *Parallelipipedum prototortuosum*, Kama.
Zone of *Pholas orientalis*, Thayetmyo.
Zone of *Aricia humerosa*, Thayetmyo.
Zone of *Cytherea erycina*, Prome.

Remarks.—The comparatively small number of thin ribs, but particularly the delicately punctured interstices, readily distinguish this species from the others.

Messrs. d' Archiac and Haime have described four different species of radially ribbed Pectines, under the names of *Pecten bouei*, *Pecten favrei*, *Pecten labadyei* and *Pecten hopkinsi*, the specific difference of three of which at least may be questioned, because the species are based on fragmentary specimens, insufficiently exhibiting the distinguishing features. To judge from the figures it appears extremely difficult, if not impossible, to distinguish between figure 1 (*Pecten bouei*) and figure 5*a* (*Pecten favrei*); there is also a great similarity between figure 4 (*Pecten hopkinsi*) and figure 5 (*Pecten favrei*). In fact there seems to be more of a difference between figure 1*c* and figure 1*d* of *Pecten bouei*, than between the latter figure and figures 3, 4, 5 and 5*a*.

Figures 2 and 2*a* (*Pecten labadyei*) form, however, unquestionably a species distinct from the former ones, and it is by no means accidental that it comes from the "Calcaire blanchâtre" while all the three former come from the "Calcaire jaunâtre."

If we go through the description of the three species it is impossible to find out a distinguishing feature; *Pecten bouei* bears "26 côtes rayonnantes," so does *Pecten favrei*, and *Pecten hopkinsi* has 25, the authors themselves say of *Pecten bouei* "cette espéce n'a point de caracteres bien particuliers." But the others have even still less, and I should think therefore that these three species may well be united under one and the same name, unless future examinations secure their specific independence better than it has been done by Messrs. d'Archiac and Haime.

Pecten kokenianus bears a great likeness to either of these three species, and I have still my doubts whether it should be considered as a distinct species or not. The general appearance is very much the same, and for instance figures 3 and 4 (*Pecten hopkinsi*) or figures 5 and *5a* of *Pecten favrei* could at any moment be considered as identical with *Pecten kokenianus*. I wish, however, to point out the differences which led me to consider it a distinct species. *Pecten kokenianus* does not seem to have attained the same size as any of the specimens described by Messrs. d'Archiac and Haime; this may, however, be overlooked inasmuch as *Pecten favrei*, figure 5, is only slightly taller than the largest specimen of *Pecten kokenianus*. The more important feature is, however, the ornamentation of the interstices of *Pecten kokenianus*, as none of the species described by Messrs. d'Archiac and Haime exhibits this character; but its absence does not prove its non-existence; it is a very delicate character, which is easily worn off, and there are numbers of specimens which even do not show a trace of it. It is, therefore, not impossible that one of the above named species possesses this character; and the question of the relationship of *Pecten kokenianus* with those from Western India must therefore remain in abeyance till the examination of the Tertiary fossils from Sind, Kutch and Kathiwar is completed.

In looking for relatives in the Tertiary fauna of Java and Sumatra, we find some species which appear to be close relatives, but it is difficult to say whether they are actually identical with the *Pecten kokenianus* without having specimens for comparison.

Professor Martin[1] mentions and figures under the name of *Pecten senatorius*, Gmelin, a species which apparently bears the closest relationship to *Pecten kokenianus*. In fact I would feel inclined to identify it with that species, were it not that the rather incomplete figure is not accompanied by a description. Martin simply states that the specimen figured agrees up to the last detail with *Pecten senatorius*, Gmelin, from the Indian Ocean.

In a subsequent paper[2] Professor Martin gives a new figure and description of the fossil *Pecten senatorius*, Reeve. The figure cannot, however, be said to be a clear one. The shell figured is a left valve which exhibits 30 ribs, and therefore as regards the general shape agrees very well with the species from Burma, but I am unable to say whether it exhibits the punctured sculpture of the interstices.

[1] Martin, Tertiärconchyllen auf Java, Leyden, 1879-80, page 124.
[2] Beitr. zur Geolog. Ost Asiens und Australiens, Vol. I, 1881-83, page 237.

Professor Martin was also struck with the likeness of the species described by him and *Pecten bouei*, d'Arch.; in fact he goes so far as to consider them both identical. I have, however, pointed out why I prefer not to go to that length, although I quite agree with Professor Martin as to the similarity of *Pecten bouei*, d' Arch., with the species under discussion.

In his last publication[1] Professor Martin discusses a number of varieties he had examined, although none is figured.

Bœttger[2] mentions three species, *Pecten bouei*, *Pecten favrei* and *Pecten hopkinsi* from the Eocene of Borneo, but whether these species are really identical or not with Messrs. d' Archiac and Haime's species may be questioned, as already mentioned by Professor Martin. All species are, however, certainly different from *Pecten kokenianus*. No living relative of *Pecten kokenianus* could be found among the fauna of the Indian Ocean, and we must suppose that it represents an extinct type; on the other hand, it is quite evident that its nearest relatives are species like *Pecten reconditus*, Sol., from the Eocene of Europe.

PECTEN IRRAVADICUS, spec. nov., Pl. IV, figs. 7, 8.

1895. *Pecten favrei*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, Vol. XXVII, Pt. 1, p. 7.

MEASUREMENTS.

(a) Right valve. Length.	Height.	L/H.	(b) Left valve. Length.	Height.	L/H.
1. 34·2 mm.	27·2 mm.	1·25	1. 32·6 mm.	27·0 mm.	1·20
2. 31·5 „	27·0 „	1·16	2. 26·6 „	25·0 „	1·06
3. 31·5 „	26·8 „	1·17	3. 24·4 „	23·1 „	1·03
4. 18·7 „	15·2 „	1·23	4. 24·3 „	20·2 „	1·20
5. 11·3 „	10·0 „	1·13	5. 22·4 „	19·0 „	1·18
			6. 21·4 „	19·1 „	1·12

The shell apparently attains a larger size than that of *Pecten kokenianus*, at least none of typical species of the latter have been observed to reach more than 30 mm. in length, while the tallest, though fragmentary, specimen of this measures nearly 37 mm. in length. The material at my disposal is not sufficient to say whether the amplitude of variation is also larger; the above figures seem to hint in this direction, and they further seem to indicate that the shell is usually more elongate than that of *Pecten kokenianus*, there being four specimens among 11 which have an index of 1·20 and over, while all the 48 specimens of *Pecten kokenianus* had an index of under 1·20. This difference, though apparently a characteristic feature, is, however, only observable when a greater number of specimens is under observation, and therefore useless for the distinction of isolated and fragmentary valves.

The shape of the valve is exactly the same as that of *Pecten kokenianus*, and it is useless to reiterate the description; the chief difference consists in the ornamentation, there are up to 40 rounded radiating ribs separated by somewhat narrower interstices; one of the chief features of *Pecten kokenianus* was the uniform strength

[1] Beitr. zur Geolog. Ost Asiens und Australiens, Vol. III, 1883-87, page 263.
[2] Die Eocänformation von Borneo. Cassel, 1875, page 52 ff.

and regularity of the ribs, but in this species just the opposite takes place; the ribs vary much in strength, some are broad and strong, others thin and slender; increase of number by bifurcation, a feature which has not been observed in any specimen of *Pecten kokenianus*, frequently takes place in this species. The ribs are crossed by fine concentric lines, but it must remain undecided whether the interstices are punctuate as in *Pecten kokenianus* or simply crossed by concentric lines; if the latter were to take place another good distinctive feature from *Pecten kokenianus* were given.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Meiocardia metavulgaris*, Singu.
Zone of *Cancellaria martiniana*, Minbu.
Zone of *Paracyathus caeruleus*, Yenangyat.

Remarks.—This species is a very common one, but it is quite certain that it never occurs together in the same beds with *Pecten kokenianus*.

No living relatives have been found among the fauna of the Indian Ocean, and *Pecten irravadicus* represents an extinct type, the probable relations of which occur, like those of *Pecten kokenianus*, in the Eocene.

Family: *AVICULIDÆ*, d'Orbigny.

Sub-family: AVICULINÆ, Stoliczka.

Genus: AVICULA, Klein.

AVICULA SUESSIANA, spec. nov., Pl. IV, figs. 9, 9*a*, 10, 10*a*, 11.

MEASUREMENTS.

	Length.		Height.
1. Left valve	36·7 mm.	(*a*)	36·7 mm.
2. ,,	28 ,,	(*b*)	12·8 ,,
3. ,,	? ,,	(*c*)	30 ,,

(*a*) Without the ventral auricle; if the length of the ventral ear is estimated at 12 mm. the total length of the hinge margin was not less than 48·7 mm.

(*b*) Posteriorly not complete; ventral ear 11·7 mm. in length.

(*c*) Posteriorly not complete; length of ventral auricle 12 mm.

1. Right valve ?		(*a*)	41 mm.
2. ,,	30 mm.	(*b*)	34 ,,
3. ,,	34 ,,		

(*a*) Length of the ventral auricle 9 mm.

(*b*) Not complete.

Though rather common, well preserved specimens are rare, as it appears that the nacreous substance of the shell was strongly affected by some chemical process; the specimens are, therefore, very brittle and no completely preserved valve has come under examination, and the characters had to be combined from examination of a number of specimens.

The shell of considerable size is inequivalve, and very inequilateral, obliquely oval, smooth, with a large, well set off ventral auricle in each valve.

(*a*) *Right valve.*—The right valve is obliquely oval in shape, apparently height and length were equal, although it is possible that the height exceeded the length just a little. It is rather flat and very inequilateral; the pointed umbo, which does not rise above the hinge margin, lies nearly terminal, just above the byssal sinus. The anterior and ventral margin form a broad oblique curve; the posterior margin was apparently straight, only a little sinuated in its middle part, joining the cardinal margin at a pointed angle and passing in a moderate sweep into the ventral margin; the hinge line is long and rectilinear.

The dorsal auricle is ill-defined, broad and not well set off from the remainder of the valve; the ventral auricle is well marked off, comparatively short, anteriorly rounded, showing a deep byssiferous notch.

Ligamental area inclined, rather broad under the umbo; surface smooth, hardly any traces of lines of growth.

(*b*) *Left valve.*—Left valve apparently of the same size and shape as the right one, but much more inflated; umbo and pedal region strongly tumid; ventral auricle large, well marked off, pointed at its extremity. Dorsal auricle the same as in the right valve.

According to Bernard the general hinge formula of *Avicula* is as follows:—

Right valve : A. III : I	L	P. I : III
Left valve : A. II	L	P. II

The singular fact should, however, be noticed that the number of lamellæ in each valve is not constant. Generally two lamellæ occur in the right valve, but there are instances where two lamellæ are developed on each side in the valve. *Avicula suessiana* exhibits another instance of this variability, inasmuch as there are certainly two dorsal lamellæ in the left valve, which should be termed LPII and IV; LPII, the posterior one of the two, is considerably stronger than LPIV; the ventral tooth LAII is short, but very strong, curved upwards. The hinge of the right valve has not been observed, but it is quite certain that only one dorsal lamella was developed which should be termed LPIII, while there was also a short low ventral lamella above LAII which corresponds therefore to LAI. Owing to the strong incurvature of the umbo, LAI has not been well observed, although it is quite certain that it existed in apparently a very weak condition. The hinge formula of *Avicula suessiana* would therefore be:

Right valve LA. III : I	L	LP. : III
Left valve LA. II	L	LP. II : IV

Geological occurrence.—

Zone of *Meiocardia metavulgaris*, Singu.

Remarks.—It is strange that the rich Miocene fauna of Java and Sumatra does not contain any species of *Avicula*, the only species known from these regions is *Avicula peregrina*, Bœttger,[1] from Borneo. The general outline of this species is apparently much the same as in the species here described, but Bœttger's figure is

[1] Eocänformation von Borneo. Cassel, 1875, page 48, Pl. VIII, figs. 83 and 84, *a* and *b*.

not particularly a good one; it certainly appears to me that in *Avicula suessiana* the angle formed by a line drawn from the umbo towards the junction of posterior and ventral margin, *i.e.*, following the line of the highest gibbosity, is more pointed than in *Avicula peregrina*.

If we look among the living species for relatives we may at once eliminate all the long winged and scaly species. Among the remaining species there is only one which exhibits some similarity to the species here described; this is *Avicula electrina*, Reeve, from the Moluccas. This species is apparently more oblique than *Avicula suessiana*, and there is some difference in the dorsal portion of the shell. In the fossil species the dorsal part of the posterior margin runs nearly perpendicular to the cardinal margin, and is flatly sinuated in the middle part, thus forming an ill-defined dorsal auricle. In *Avicula electrina* it runs very obliquely, forming an obtuse angle with the hinge line and is hardly sinuated.

2. Sub-family: VULSELLINÆ, Stoliczka.

Genus: VULSELLA, Lamarck.

VULSELLA LINGUA-TIGRIS, spec. nov., Pl. IV, figs. 12, 13, 14.

MEASUREMENTS.

Length.	Height.	L/H.
29·7 mm.	14·3 mm.	2·08

The shell is irregular in shape, generally transversely oval, somewhat tongue-shaped; the length exceeds the height considerably and the index L/H is therefore rather high; it is apparently sub-equivalve, very inequilateral and rather flat.

The umbo is pointed, strongly turned in dorsal direction, almost terminal.

The pedal region is nearly rudimentary, the siphonal region very elongate and broad.

A part of the cardinal margin, the anterior and ventral margin, form rather an irregular curve, which is strongly turned in dorsal direction at either end; the posterior margin is long and forms, together with a part of the cardinal margin, an irregular curve, which passes at either end into the anterior ventral curve.

The ornamentation consists of numerous lamellous concentric striæ of growth following each other in irregular intervals.

Internal characters not observed.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Meiocardia metavulgaris*, Singu.
Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—The advisibility of giving a specific name to the species here described may perhaps be questioned, but as hitherto only one species, *Vulsella legumen*, d'Arch. and Haime, has been described from Western India, a species which is certainly different from the one here examined, and as no other species is

known either from the Tertiary system of Burma or from Java and Sumatra, a mistake is not likely to occur, although the description leaves much to be desired.

Vulsella lingua-tigris is easily distinguished from *Vulsella legumen* by its smaller size, its more oblong and less accuminate shape, and the more delicate striæ of growth.

I cannot find any living species to which I might compare the Miocene one, a comparison which, owing to the rather defective state of the fossil specimens, would perhaps be of no great value.

Family : *MYTILIDÆ*, Lamarck.

1. Genus : MYTILUS, Brugière.

Mytilus (Septifer) nicobaricus, Reeve, Pl. IV, figs. 15, 15*a*, 16, 17, 17*a*, Pl. V, figs. 1, 1*a*.

Mytilus nicobaricus, Reeve, Monograph of the genus *Mytilus*, Pl. IX, fig. 42.

Measurements.

(*a*) Left valve.	Length.	Height.	L/H.	(*b*) Right valve.	Length.	Height.	L/H.
1.	35·7 mm.	16·3 mm.	2·19	1.	33·2 mm.	14·7 mm.	2·25
2.	33·0 ,,	16·1 ,,	2·36	2.	30·8 ,,	14·4 ,,	2·13
3.	28·6 ,,	14·3 ,,	2·00	3.	28·4 ,,	14·2 ,,	2·00
4.	17·2 ,,	9·1 ,,	1·90	4.	27·8 ,,	13·0 ,,	4·10
				5.	27·3 ,,	12·9 ,,	2·11

The shell is transversely rhomboidal in shape, very inequilateral and much longer than high. The index L/H is therefore rather high, and if from the above few specimens an idea may be formed, the amplitude of variation is rather large, inasmuch as the formula would be as follows :—

$$\text{var. } 35 \begin{array}{c} 2{\cdot}25 \\ | \\ 1{\cdot}90 \end{array} \text{ average } \begin{cases} 2{\cdot}075 \text{ math.} \\ 2{\cdot}081 \text{ calc.} \end{cases}$$

This rather large amplitude is chiefly caused by the smallest specimen having a comparatively small index 1·90, but as it is well preserved and the measurements accurate, it is probable that in young specimens the relation between length and height differed somewhat from that of full-grown specimens, and that the young specimens appeared therefore less elongate and much higher. That the small index 1·90 is not an accidental exception seems to be proved by the observation that in the above formula the mathematical average of 2·075 coincides as nearly as possible with the calculated average of 2·081. However, further observations are required to confirm the above view as to the variation of shape of this species.

The umbo is very pointed, low, depressed and nearly terminal, being directly above the anterior margin.

The pedal region is very short and rudimentary, the siphonal region long and broadly expanded.

The anterior margin is extremely short, forming a right angle with the long and straight ventral margin, which is, however, just perceptibly sinuated in its anterior part. The posterior margin is very long, angularly broken ; its ventral portion is

broadly rounded and passes in a broad sweep into the ventral margin; its dorsal portion is straight, nearly parallel to the ventral margin, forming an obtuse angle with the straight oblique cardinal margin; the latter forms a very pointed angle with the ventral margin.

The surface is moderately inflated; a strong rounded keel runs from the umbo towards the junction of ventral and posterior margin, dividing the valves in two very unequal portions; the ventral portion is narrow and drops nearly perpendicularly, exhibiting a very shallow depression in the middle, while the dorsal portion is broad and gently inclined.

The whole surface is closely covered with fine, round, little irregular radiating ribs separated by linear interstices. Towards the margins these ribs often bifurcate, but sometimes new ones are intercalated between the older ones. Ribs and interstices are crossed by numerous very fine concentric lines, which are, however, easily worn off on the ribs, and well preserved only in the interstices, where they produce a delicate lattice work.

Owing to the shape of the shell the arrangement of the ribs is a peculiar one; there are three primary bundles of ribs, one on the ventral portion, and two on the dorsal portion of the shell. As far as can be judged these bundles are not differentiated during the nealogic stage, but with advancing size, the growth of the shell forces the primary bundles to diverge, because each rib continues to grow in a straight direction, and secondary ribs, which therefore do not reach the umbo, appear in the intermediate spaces.

The two dorsal bundles exhibit this feature very well, while it is less well seen between the ventral and dorsal bundle.

Internal characters not observed.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.

Remarks.—No similar species has been described either from Western India, or Java or Sumatra, but it is quite certain that the living *Mytilus* (*Septifer*) *nicobaricus* from the Nicobar Islands is identical with the Miocene species. The shape and the ornamentation is so exactly alike, that I fail to discover any differences.

2. Genus: MODIOLA, Lamarck.

Two species belonging to this genus have been described which can be easily distinguished in the following way:—

A. Shell very gibbous, ventral portion narrow, perpendicularly inclined.
 1. *Modiola buddhaica*, spec. nov.

B. Shell less inflated, ventral portion broad and less steeply inclined.
 2. *Modiola pseudobuddhaica*, spec. nov.

I found it impossible to settle the question of the relationship of these two species both being too ill-preserved and their characters too indifferent to allow of a comparison from figures only. It seems, however, certain that both species represent types which are extinct among the present fauna of the Indian Ocean,

but whether their nearest relatives lived in the Eocene of India or Europe cannot be stated yet. There are certainly some species among the fauna of the Paris Eocene like ***Modiola subangulata***, Desh., which exhibit a certain similarity with ***Modiola buddhaica***, but nothing can be said with regard to ***Modiola pseudo-buddhaica***.

MODIOLA BUDDHAICA, spec. nov., Pl. IV, figs. 18, 18*a*, Pl. V, fig. 2, *a-b*.

MEASUREMENTS.

	Length.	Height.	Thickness.	L/H.
(*a*) Complete shell .	35·0 mm. .	15·5 mm. .	11·5 mm. .	2·25
(*b*) Right valve .	26·6 „ .	12·3 „ .	9·1 „ .	2·16

The shell which apparently does not attain a large size, is transversely elongate, kidney shaped, and much longer than high ; the index L/H is therefore rather high though its amplitude is not known for the present; it is very inequilateral and strongly inflated. The umbo is small, a little pointed, depressed and terminal, right on the anterior margin.

The pedal region is very short and rudimentary, the siphonal region elongate, curved and narrow.

The rounded, very short anterior margin merges into the long ventral margin which is broadly sinuated in the middle. The posterior margin which is long and convex, forms a pointed angle with the ventral margin, the corner of which is rounded off, and a very obtuse angle with the short, oblique and straight cardinal margin.

As both valves are strongly inflated, the total thickness of the shell exceeds its height considerably. An obtuse, curved keel begins at the umbo and runs, gradually becoming flatter, towards the posterior corner; on the ventral side of this keel the surface drops nearly perpendicularly, being, however, slightly concave from a shallow median depression, which broadly sinuates the ventral margin. Behind the keel the surface drops less steeply. There is no surface ornamentation, except a few fine concentric lines of growth.

Geological occurrence.—

Zone of ***Mytilus nicobaricus***, Singu.

Zone of ***Meiocardia metavulgaris***, Singu.

Remarks.—Messrs. d' Archiac and Haime have described two species of ***Mytilus***, which, as already Bœttger remarked, ought to be better considered as belonging to ***Modiola***, viz., ***Mytilus nummuliticus*** and ***Mytilus subobtusus***, both of which bear no similarity to the species here described. Bœttger describes a new species ***Modiola*** (***Brachydontes***) ***tochophora***, which is, however, also widely different from the Burma species.

Modiola subangulata, Deshayes, from the Calcaire grossier supérieur, although distinctly different, might perhaps be compared with ***Modiola buddhaica***, which is, however, less broad, apparently higher inflated, but the chief distinguishing feature consists in the narrow, perpendicularly inclined ventral region of the valve; in ***Modiola subangulata*** this part is rather broad and gently inclined.

No relatives are found in the Tertiary beds from other parts of Europe, and we

have to turn to the living species for comparison. A large number can be excluded at once, and among the remaining species there is hardly one which bears any similarity. *Modiola traillei*, Reeve, from Malacca could in a distant way be compared with the Burma species, inasmuch as exhibiting the same narrow and steep perpendicular, ventral region, but in all other regards it is perfectly different.

The chief distinguishing features of *Modiola buddhaica* are therefore its great gibbosity, its short cardinal margin and the narrow perpendicularly inclined ventral portion of the surface, in connection with a steeply inclined dorsal one.

MODIOLA PSEUDOBUDDHACIA, spec. nov., Pl. V, figs. 3, 3*a*.

MEASUREMENTS.

Length.	Height.	L/H.
35·6 mm.	17·8 mm.	2·00

The shell is transversely elongate, much longer than high; the index L/H is therefore rather high; it is moderately inflated and very inequilateral. The umbo is obtuse, depressed, very prosogyric, and right above the anterior margin.

The podal region is very short, rudimentary, the siphonal region very long, broadly expanded. The anterior margin is very short, rounded and forms a right angle with the long and straight ventral margin which is slightly sinuated in the middle. The posterior margin is long, convex, anteriorly inclined and forms apparently a pointed angle, the corner of which is rounded off, with the ventral margin. The cardinal margin is long, straight, obliquely inclined and forms an obtuse angle with the posterior margin.

A flat broad keel runs from the umbo to the posterior corner; on its ventral side the surface is moderately inclined, having a broad and shallow depression in the middle; on the dorsal side the surface is still less inclined.

The ornamentation consists of coarse, concentric striæ of growth only.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.

Remarks.—It was with great reluctance that I dealt with this single specimen under a new name, because its similarity to *Modiola buddhaica* is very great, but on comparison of the two specimens, certain distinctive features were noticed, of which I am, however, not quite certain how far they are to be relied upon, as only a single specimen has come under consideration.

With regard to the general shape it will be seen that the shell of *Modiola buddhaica* is curved in dorsal direction, while it is nearly straight in *Modiola pseudobuddhaica*; the former species remains narrow in ventro-dorsal direction throughout, while the latter is broadly expanded towards the siphonal region, and in the first species the posterior margin is very long and broadly curved and the cardinal margin, on the other hand, very short; in the second species the posterior margin is relatively short, while the cardinal margin is long.

The great gibbosity and the perpendicularly inclined ventral region, form a very characteristic feature of *Modiola buddhaica*. *Modiola pseudobuddhaica* is much less inflated and the ventral region is much less inclined.

I think that the above-mentioned differences justify a specific separation; no living or fossil relative of this species could be traced.

Genus: LITHODOMUS, Cuvier.

LITHODOMUS, SPEC., Pl. V, figs. 4, *a-b*, 5.

Of frequent occurrence are nodules of clay which are perfectly riddled by the holes of some burrowing mollusk. The holes became afterwards filled up with sandy material, and they represent now the well-known club-shaped casts, generally attributed to the genus *Lithodomus*. The shell which has produced these holes cannot have been a large one, as the majority of the casts measure under 10 mm. There are only very few specimens which are larger, the largest measuring 25·5 mm. in length, having a greatest thickness of 12·5 mm. As is usual with this species, its occurrence is gregarious.

No trace of the shell has been preserved. I refrain therefore from giving a specific name although I think it useful to give a figure by way of illustrating the characteristical occurrence.

Geological occurrence.—

Zone of *Meiocardia metavulgaris*, Singu.

Family: *PINNIDÆ*, Gray.

Genus: PINNA, Linné.

PINNA, SPEC.

There are a few casts which exhibit the characteristic triangular, pointed shape and the elongate radiating ribs of the genus *Pinna*; the specimens are, however, too badly preserved to allow for a specific determination. To judge from their appearance the shell was certainly smaller than Martin's *Pinna exilium*, provided that species attained the size attributed to it by Professor Martin.

Geological occurrence.—

Zone of *Pholas orientalis*, Thayetmyo.
Zone of *Cancellaria martiniana*, Minbu.

Family: *ARCIDÆ*, Lamarck.

Sub-family: ARCINÆ, H. and A. Adams.

Genus: ARCA, Linné.

So far the genus *Arca* has furnished the largest number of well determined species, *viz.*, 11, or if the independence of the genus *Parallelipipedum* is not recognized there are 12 species altogether. The majority appear to belong to the

sub-genus *Anomalocardia*, but there are three species which probably represent as many sub-genera. The following is the synopsis of the species here distinguished:

A. Shell transversely elongate,
  (*a*) Ribs rounded, granular.
    (*aa*) All ribs of the left, but only the anterior six ribs of the right valve granular.
      1. *Arca burnesi*, d' Archiac and Haime.
    (*bb*) All ribs of the left and right valve granular.
      2. *Arca theobaldi*, spec. nov.
  (*b*) Ribs angular, smooth and flat.
    (*aa*) All ribs undivided.
      3. *Arca thayetensis*, spec. nov.
    (*bb*) Only a few anterior ribs bifurcated.
      4. *Arca metabistrigata*, spec. nov.
    (*cc*) All ribs bifurcated, except the few hindmost ones.
      5. *Arca bistrigata*, Dunker.
  (*c*) Ribs rounded, smooth.
    (*aa*) Furrowed on top.
      6. *Arca oldhamiana*, spec. nov.
B. Shell orbicular.
  (*a*) Ribs of both valves smooth.
      7. *Arca yawensis*, spec. nov.
  (*b*) Ribs of right valve smooth, of left valve granular.
      8. *Arca myoënsis*, spec. nov.
C. Shell rectangular, ribs broad, flat.
      9. *Arca nannodes*, K. Martin.
D. Shell trapeziform, ribs fine, filiform.
      10. *Arca bataviana*, K. Martin.
E. Shell rhomboidal, ribs broad, flat.
      11. *Arca peethensis*, d' Archiac and Haime.

Seven out of these eleven species, *viz.*—

Arca oldhamiana, spec. nov.,
,, *yawensis*, spec. nov.,
,, *myoënsis*, spec. nov.,
,, *nannodes*, K. Martin,
,, *peethensis*, d' Archiac and Haime,
,, *thayetensis*, spec. nov.,
,, *bataviana*, K. Martin,

represent types which are unquestionably extinct among the present fauna of the Indian Ocean. But while no living relatives could be traced of the first five species which therefore represent entirely extinct types, the last two, *viz.*, *Arca thayetensis* and *Arca bataviana*, have unquestionably living relatives among the fauna of the Philippine Islands.

Out of the remaining species one, *Arca bistrigata*, is unquestionably identical with the same species of that name living in the Indian Ocean, while *Arca metabistrigata* apparently represents a permanent evolutionary type of this species. The same applies to *Arca burnesi* and *Arca theobaldi* which probably represent two different evolutionary stages of the living *Arca granosa*, Reeve.

ARCA (ANOMALOCARDIA) BURNESI, d'Archiac and Haime, Pl. V, figs. 6, *a-f*, 7, *a-b*, 8, *a-b*, 9, *a-b*, 10, *a-d*.

1853. *Arca burnesi*, d' Arch. and Haime, Desc. des anim. foss. du groupe num. de l'Inde, p. 264, pl. XXII, fig. 5 *a, b, c, d*.

MEASUREMENTS.

(*a*) Specimens exhibiting both valves.

	Length.	Height.	Thickness.	L/H.
1.	24·4 mm.	15·5 mm.	14·5 mm.	1·57
2.	17·6 ,,	12·5 ,,	11·0 ,,	1·40
3.	14·1 ,,	10·1 ,,	9·2 ,,	9·0
4.	14·3 ,,	10·0 ,,	8·0 ,,	1·42

(*b*) Right valve.

	Length.	Height.	Thickness.	L/H.
1.	27·0 mm.	18·2 mm.	8·5 mm.	1·36
2.	26·5 ,,	16·5 ,,	8·2 ,,	1·60
3.	26·0 ,,	19·1 ,,	8·5 ,,	1·36
4.	25·5 ,,	14·5 ,,	7·7 ,,	1·62
5.	25·0 ,,	[illegible] ,,	8·6 ,,	1·62
6.	24·8 ,,	15·2 ,,	7·8 ,,	[illegible]
7.	24·6 ,,	15·7 ,,	8·0 ,,	1·56
8.	24·4 ,,	15·4 ,,	7·7 ,,	1·58
9.	24·4 ,,	15·1 ,,	7·8 ,,	1·61
10.	24·4 ,,	16·0 ,,	7·5 ,,	1·53
11.	24·2 ,,	17·0 ,,	8·2 ,,	1·42
12.	23·6 ,,	15·3 ,,	6·8 ,,	1·45
13.	23·5 ,,	14·6 ,,	6·7 ,,	1·54
14.	23·2 ,,	18·9 ,,	6·8 ,,	1·52
15.	23·1 ,,	15·0 ,,	7·3 ,,	1·54
16.	22.5 ,,	14·7 ,,	7·1 ,,	1·54
17.	[illegible] ,,	14·0 ,,	7·0 ,,	1·60
18.	22·4 ,,	15·7 ,,	7·5 ,,	1·42
19.	22·4 ,,	14·1 ,,	7·3 ,,	1·58
20.	22·4 ,,	13·5 ,,	6·7 ,,	1·65
21.	22·0 ,,	14·0 ,,	6·9 ,,	1·57
22.	21·9 ,,	14·9 ,,	6·9 ,,	1·46
23.	21·7 ,,	14·0 ,,	6·5 ,,	1·55
24.	[illegible] ,,	14·4 ,,	6·7 ,,	1·50
25.	21·2 ,,	14·9 ,,	6·4 ,,	1·42
26.	21·0 ,,	14·8 ,,	7·0 ,,	1·41
27.	20·7 ,,	14·1 ,,	6·6 ,,	1·46
28.	22·0 ,,	13·7 ,,	6·4 ,,	1·60
29.	20·2 ,,	15·2 ,,	6·8 ,,	1·32
30.	20·3 ,,	15·0 ,,	6·7 ,,	1·35
31.	19·8 ,,	12·0 ,,	6·5 ,,	1·65
32.	18·7 ,,	12·8 ,,	5·8 ,,	1·39
33.	17·6 ,,	14·1 ,,	5·8 ,,	1·55
34.	13·6 ,,	9·4 ,,	5·2 ,,	1·44
35.	13·6 ,,	9·6 ,,	4·5 ,,	1·41
36.	12·8 ,,	9·9 ,,	5·0 ,,	1·30
37.	11·9 ,,	8·8 ,,	4·3 ,,	1·35
38.	11·1 ,,	7·8 ,,	4·2 ,,	1·42
39.	11·0 ,,	8·6 ,,	[illegible] ,,	1·28
40.	10·9 ,,	7·3 ,,	3·7 ,,	1·49
41.	10·8 ,,	7·1 ,,	3·0 ,,	[illegible]
42.	10·5 ,,	7·5 ,,	3·4 ,,	1·40
43.	10·5 ,,	7·4 ,,	3·4 ,,	1·42
44.	10·5 ,,	6·7 ,,	3·2 ,,	1·56

(*c*) Left valve.

	Length.	Height.	Thickness.	L/H.
1.	27·5 mm.	18·2 mm.	8·9 mm.	1·51
2.	27·3 ,,	18·4 ,,	8·8 ,,	1·42
3.	26·7 ,,	16·8 ,,	8·0 ,,	1·58
4.	26·5 ,,	16·8 ,,	8·4 ,,	1·57
5.	26·2 ,,	17·1 ,,	8·8 ,,	1·54
6.	25·5 ,,	18·9 ,,	8·8 ,,	1·34
7.	25·2 ,,	17·4 ,,	7·4 ,,	1·44
8.	25·0 ,,	16·8 ,,	7·9 ,,	1·48
9.	24·6 ,,	18·6 ,,	8·6 ,,	1·32
10.	24·4 ,,	17·3 ,,	8·2 ,,	1·41
11.	24·3 ,,	16·5 ,,	8·8 ,,	1·47
12.	24·2 ,,	16·0 ,,	8·4 ,,	1·51
13.	24·1 ,,	17·1 ,,	8·7 ,,	1·40
14.	23·8 ,,	14·1 ,,	7·8 ,,	1·68
15.	23·6 ,,	17·1 ,,	8·2 ,,	1·38
16.	23·6 ,,	15·3 ,,	7·3 ,,	1·54
17.	23·6 ,,	15·4 ,,	7·9 ,,	1·53
18.	23·0 ,,	15·1 ,,	7·5 ,,	1·52
19.	23·0 ,,	16·5 ,,	7·6 ,,	1·40
20.	22·6 ,,	14·3 ,,	[illegible] ,,	1·57
21.	22·6 ,,	15·2 ,,	7·7 ,,	1·48
22.	22·5 ,,	15·6 ,,	7·3 ,,	1·44
23.	22·5 ,,	16·4 ,,	7·3 ,,	1·37
24.	22·5 ,,	14·8 ,,	7·0 ,,	1·51
25.	22·4 ,,	15·3 ,,	7·7 ,,	1·46
26.	22·4 ,,	14·4 ,,	7·4 ,,	1·55
27.	22·0 ,,	16·0 ,,	7·6 ,,	1·37
28.	21·8 ,,	14·7 ,,	7·1 ,,	1·48
29.	21·7 ,,	15·3 ,,	6·8 ,,	1·41
30.	21·0 ,,	15·5 ,,	7·1 ,,	1·35
31.	21·6 ,,	14·7 ,,	7·2 ,,	1·47
32.	21·1 ,,	15·0 ,,	7·9 ,,	1·40
33.	20·8 ,,	15·2 ,,	6·8 ,,	1·36
34.	20·0 ,,	12·8 ,,	6·4 ,,	1·56
35.	19·8 ,,	12·7 ,,	6·3 ,,	1·55
36.	19·5 ,,	11·8 ,,	6·2 ,,	1·65
37.	19·2 ,,	14·7 ,,	[illegible] ,,	1·30
38.	[illegible] ,,	13·1 ,,	6·6 ,,	1·40
39.	17·1 ,,	11·8 ,,	6·2 ,,	1·44
40.	17·1 ,,	13·3 ,,	6·3 ,,	1·28
41.	17·0 ,,	11·5 ,,	5·6 ,,	1·48
42.	16·0 ,,	11·0 ,,	5·0 ,,	1·45
43.	15·3 ,,	10·8 ,,	5·2 ,,	1·41
44.	14·8 ,,	11·1 ,,	5·2 ,,	1·33
45.	14·2 ,,	10·0 ,,	? ,,	1·42
46.	13·5 ,,	9·6 ,,	5·0 ,,	1·40
47.	12·9 ,,	9·2 ,,	5·0 ,,	1·40
48.	12·3 ,,	9·0 ,,	[illegible] ,,	1·36
49.	10·7 ,,	8·3 ,,	4·0 ,,	1·29
50.	10·2 ,,	6·8 ,,	3·4 ,,	1·50
51.	10·1 ,,	7·8 ,,	[illegible] ,,	1·29
52.	9·3 ,,	6·8 ,,	4·3 ,,	1·36
53.	8·0 ,,	6·3 ,,	2·7 ,,	1·27
54.	7·6 ,,	5·3 ,,	2·3 ,,	1·43
55.	4·9 ,,	4·2 ,,	1·7 ,,	1·17

In the above table the specimens have been arranged according to size in descending order, and in going through the figures it will be seen at once that absolute size and index L/H are in no relation whatsoever; the large specimen No. 5 has an index of 1·36, while specimen No. 49, which is of nearly the same size, has an index of 1·51; the first is, therefore, comparatively short, while the second is elongate; it will be further seen that comparatively young specimens may have a very high index, while others have a small one only; for instance, No. 48 has an index of 1·56, while No. 97, which is only 0·2 mm. smaller, has an index of 1·29. So far these figures tend to prove that there is no general rule with regard to the shape during the time of growth, though it might perhaps be supposed that young ones are more orbicular than full grown specimens. The figures seem rather to prove that the tendency to form the shape of the shell is developed at an early stage already, and is retained during the time of growth.

Another feature is, however, proved by these figures, and this is a great tendency towards variation, which ranges from 1·17 to 1·68. We have, therefore, two extreme varieties, one of which has an almost orbicular shell, while the other has a transversely elongate shell; if both specimens were found isolated, without the connecting links, I have not the slightest doubt that many a palæontologist would consider them as different species, by putting too great a stress on the external feature, *viz.*, the shape of the circumference of the valves, and yet these two specimens are only the extreme ends of an almost uninterrupted chain.

If regardless of size, the specimens are arranged according to their indices in ascending order, underneath of each index the number of specimens being written, we obtain the following table:—

Index	1·17	1·18	1·19	1·20	1·21	1·22	1·23	1·24	1·25	1·26
Number of specimens	1	...	...	...	...	...	...	...	...	...
Index	1·27	1·28	1·29	1·30	1·31	1·32	1·33	1·34	1·35	1·36
Number of specimens	...	3	2	2	...	3	1	1	3	4
Index	1·37	1·38	1·39	1·40	1·41	1·42	1·43	1·44	1·45	1·46
Number of specimens	2	1	1	9	5	8	1	4	1	3
Index	1·47	1·48	1·49	1·50	1·51	1·52	1·53	1·54	1·55	1·56
Number of specimens	2	5	1	2	2	5	1	5	3	3
Index	1·57	1·58	1·59	1·60	1·61	1·62	1·63	1·64	1·65	1·66
Number of specimens	4	3	...	6	1	2	1	...	3	...
Index	1·67	1·68	...	...	...	...	...	...	...	...
Number of specimens	...	1	...	...	...	...	...	...	...	...

The above chain is almost uninterrupted from 1·28 to 1·65, there being only one gap each at 1·31, 1·59 and 1·64. I considered these gaps, however, so unimportant, that I think I am fully justified in saying that ***Arca (Anomalocardia) burnesi*** has an uninterrupted range of variety from index 1·28 to 1·63; in fact if we disregard the large gap at the beginning and the smaller at the end, we may say the amplitude extends from 1·17 to 1·68. The relative size of the range of variation could be expressed in the following short way:—

$$\text{Var. 52} \; \begin{matrix} 1{\cdot}68 \\ | \\ 1{\cdot}17 \end{matrix} \quad \text{average.} \begin{cases} 1{\cdot}\ 425 \text{ math.} \\ 1{\cdot}\ 444 \text{ calc.} \end{cases}$$

which means that, the range of variation extends over 52 indices, the smaller of which is 1·17, in other words, contains comparatively orbicular shells, while the largest is 1·68, including the more elongate varieties.

We further notice at once that far the majority of the specimens, *viz.*, 69, have an index L/H from 1·38 to 1·58, those below 1·38 number only 25, and those above 1·58 not more than 13. I think it will therefore be useful to distinguish as—

Var. *rotundata*	all specimens having L/H under	1·38
Var. *media*	" " " " between	1·38 and 1·58
Var. *elongata*	" " " " above	1·58

Both valves are strongly, but regularly inflated, the point of highest inflation being below the umbo. The thickness of both valves frequently exceeds their height, as is illustrated by numerous instances above.

The general shape of the valves is transversely oval, but as already pointed out, this shape undergoes many variations. The umbos are inflated, incurvated, prosogyric and fairly distant from each other, and situated in the anterior third of shell. The pedal region is short, rounded, the siphonal one long, but somewhat compressed. The anterior margin forms a right angle with the hinge margin and passes gradually into the strongly curved ventral margin, which in its turn passes into the oblique posterior margin, which forms an obtuse angle with the long rectilinear cardinal margin.

The ligamental area is long, slightly concave, but not very wide, particularly at its anterior extremity, lined by a fine, somewhat nodular edge; there are always a few, sharply engraved cartilage grooves particularly on its posterior part.

The hinge consists of about 60 lamellar teeth of which the anterior and posterior ones are the largest and obliquely placed, while those in the middle are the smallest and placed perpendicular to the hinge margin.

The muscular scars are well defined, the anterior one, about half the size of the posterior one which is of considerable length. Pallial impression sharp, pretty close to the deeply crenulated margin.

Although the general appearance of the ornamentation of both valves is the same, they differ considerably in detail. The ornamentation consists of radiating ribs the number of which varies considerably; the smallest number noticed is 22 and the highest 32. The ribs are all equal in strength, exhibiting an angular section by having a flat top and perpendicularly inclined sides. On the right valve the interstices are broader than the ribs, and as the interstices of the right are interlocked with the ribs of the left valve, the reverse is to be noticed on the latter, *viz.*, the ribs are broader than the interstices.

There is still another difference in the ornamentation of both valves; on the left valve all the ribs except the last 7 or 6 show numerous, very regular and deep concentric equidistant notches on the top, giving them a peculiar granular appearance. On the right valve only the five or six anterior ribs exhibit this sculpture, while the remainder are smooth. In both valves the interstices bear numerous

very fine equidistant concentric lines, which are apparently a little more closely set on the left than on the right valve.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—The general transversely oval shape as well as the character of the ribs distinguish this species easily from all the others.

This species has been first described by Messrs. d'Archiac and Haime, who have well recognised the chief distinguishing features. Subsequently it has been found in Java, and figured and described by Professor Martin who mentions also another species which seems to be so closely related to *Arca burnesi*, *viz.*, *Arca biformis*, that the latter had perhaps been better considered as a variety only, particularly as only two valves have been found of this species, and as *Arca burnesi* apparently shows a great variation with regard to the shape and sculpture of the valves.

I have before me a small specimen of *Arca burnesi*, showing both valves, the left valve of which shows in a beautiful way the sculpture being considered peculiar to *Arca biformis*, namely, the fine concentric lines in the interstices which connect the granules of two adjoining ribs.

In my previous memoir I described under the name of *Daphnoderma cœlata*, Reeve, a species which I considered to be identical with *Arca burnesi*, d'Archiac. Having now better preserved material at my disposal I am now able to state with certainty, that this species is not identical with *Arca burnesi*, but differs materially as regards the shape and sculpture of the shell from it.

It is extremely difficult to say anything definite about the living relatives of this species, without having specimens of the species referred to, as the descriptions and figures given in Reeve's Monograph of the Genus *Arca* are somewhat insufficient.

The species nearest related to *Arca burnesi* seems to be *Arca clathrata*, Reeve,[1] from the Philippine Islands. I am, however, unable to judge from the figure solely how far the relationship goes. It may be also possible that *Arca burnesi* is the ancestor of the living *Arca granosa*, Reeve, a species which when young must have had a great similarity to the fossil species. If this view should be proved correct, the above would be another instance of the peculiar evolution some species have taken since the Miocene times, their ancestors being distinguished by a more delicate sculpture, while the present species exhibit the same features though in a more coarse way.

[1] It may be mentioned that this species should be given a new name, because this name was, as far back as 1816, given by Defrance to a species which is certainly different from *Arca clathrata*, Reeve.

Arca (Anomalocardia) theobaldi, spec. nov., Pl. V, figs. 11, *a-b*, 12, *a-b*, 13, *a-b*, 14, *a-b*, Pl. VI, fig. 1, *a-c*.

Measurements.

(*a*) Specimens having both valves.

	Length.	Height.	L/H.
1.	14·7 mm.	10·8 mm.	1·36
(*b*) Right valve.			
2.	23·1 mm. .	14·7 mm. .	1·57
3.	19·4 „ .	14·0 „ .	1·38
4.	16·2 „ .	11·4 „ .	1·42
5.	14·6 „ .	10·6 „ .	1·37
6.	14·3 „ .	11·7 „ .	1·23
7.	14·0 „ .	10·7 „ .	1·30
8.	14·0 „ .	10·5 „ .	1·34
9.	12·4 „ .	8·8 „ .	1·40
10.	12·1 „ .	9·0 „ .	1·34
11.	11·9 „ .	8·2 „ .	1·29
12.	11·4 „ .	9·2 „ .	1·39
13.	9·7 „ .	7·5 „ .	1·30
14.	9·3 „ .	6·9 „ .	1·34
15.	8·2 „ .	6·4 „ .	1·28
16.	7·3 „ .	5·7 „ .	1·28
17.	7·2 „ .	5·7 „ .	1·36
18.	6·7 „ .	5·2 „ .	1·28
19.	6·6 „ .	4·9 „ .	1·34
20.	6·0 „ .	4·3 „ .	1·39
21.	6·0 „ .	4·5 „ .	1·33
(*c*) Left valve.			
22.	24·8 mm. .	17·9 mm. .	13·8

Left valve—*contd.*

	Length.	Height.	L/H.
23.	24·7 mm. .	17·3 mm. .	1·42
24.	19·6 „ .	15·1 „ .	1·30
25.	19·2 „ .	14·0 „ .	1·37
26.	17·8 „ .	13·7 „ .	1·30
27.	17·7 „ .	13·2 „ .	1·34
28.	17·0 „ .	12·8 „ .	1·33
29.	16·3 „ .	12·8 „ .	1·27
30.	15·5 „ .	11·1 „ .	1·36
31.	15·0 „ .	11·1 „ .	1·35
32.	14·8 „ .	11·6 „ .	1·27
33.	14·3 „ .	11·4 „ .	1·24
34.	13·3 „ .	10·2 „ .	1·29
35.	13·0 „ .	10·3 „ .	1·26
36.	12·9 „ .	9·9 „ .	1·30
37.	12·1 „ .	10·1 „ .	1·20
38.	12·0 „ .	9·0 „ .	1·33
39.	11·8 „ .	9·3 „ .	1·26
40.	11·3 „ .	9·4 „ .	1·20
41.	11·3 „ .	8·8 „ .	1·28
42.	11·3 „ .	9·0 „ .	1·25
43.	10·7 „ .	8·4 „ .	1·27
44.	8·5 „ .	6·7 „ .	1·27
45.	7·7 „ .	6·5 „ .	1·18

The specimens have again been arranged according to size; and in going through these figures, we notice the same feature that the size of the index is independent of the absolute size of the shell. There is, however, another feature noticed though not with great distinctness; it seems as if the younger specimens possessed a smaller index than the older ones; in other words, that during the nealogic stage the shell had a more orbicular shape than in later stages. This feature would be of some significance, as it would prove that this species has been derived from a more orbicular species, and as it is highly probable that it is the descendant of *Arca (Anomalocardia) burnesi* the more orbicular varieties of that species developed into this one.

If the indices are arranged in the same way as before, we have the following table:—

Index . . .	1·18	1·19	1·20	1·21	1·22	1·23	1·24	1·25	1·26	1·27	1·28
Number of specimens	1	...	2	...	1	...	1	1	2	4	4
Index . . .	1·29	1·30	1·31	1·32	1·33	1·34	1·35	1·36	1·37	1·38	1·49
Number of specimens	2	5	...	1	2	5	1	2	2		2
Index . . .	1·40	1·41	1·24	1·43	1·44	1·45	1·46	1·47	1·48	1·49	1·50
Number of specimens .	1	...	2	...	...	...	...	...	...	...	...
Index . . .	1·51	1·52	1·53	1·54	1·55	1·56	1·57	...	...	...	...
Number of specimens .	...	...	...	...	...	...	1	...	...	...	...

The chain is almost uninterrupted from 1·24 to 1·42, there being only two gaps; taken as a whole the range would be from 1·18 to 1·57, there being a large gap after 1·42. Variety 1·57 stands therefore quite by itself separated by a wide gap from the remainder which range from 1·18 to 1·42. I have carefully examined var. 1·57; it is perfectly preserved and not squashed in any way, which might perhaps account for its elongate shape. As it is, it forms a solitary instance, while far the majority of the shells prove that the tendency of the animal was rather to form orbicular, than elongate shells. If var. 1·57 did not exist, the variability of this species would be a comparatively small one, as it would only be var. 25. Under the above circumstances it is, however, greater and the formula must be written—

$$\text{Var. } 40 \begin{matrix} 1{\cdot}57 \\ | \\ 1{\cdot}18 \end{matrix} \text{ Average } . \begin{cases} 1{\cdot}375 \text{ math.} \\ 1{\cdot}324 \text{ calc.} \end{cases}$$

The comparison of the two formulæ of variety of two species so closely related as *Arca* (*Anomalocardia*) *burnesi* and *theobaldi*, the latter of which is most probably the descendant of the former, is of great interest.

In the first instance we see that the tendency of variation is much smaller in *Arca* (*Anomalocardia*) *theobaldi* than in *Arca* (*Anomalocardia*) *burnesi*, the respective figures being var. 40 and var. 52; in fact if it would not be for the isolated var. 1·57 of *Arca* (*Anomalocardia*) *theobaldi* the difference would be greater still, inasmuch as the figures were var. 25 and var. 52; in other words, the tendency of variation in the first species would be half of that of the second.

If we again group the specimens into three classes we notice that there are—

39	specimens having an index from	1·17 to 1·38
6	" " " " "	1·38 to 1·42
1	" " " " "	1·43 to 1·58

That is to say, one specimen only just falls short of the limit of those I have distinguished as *var. elongata* in the former species, six only come under the *var. media*, while the majority, *viz.*, 39, fall under the *var. rotuntada*. We see therefore that while in *Arca* (*Anomalocardia*) *burnesi* the *var. media* formed far the overwhelming majority, in the above species the *var. rotuntada* assumes this place.

This feature is still more pronounced if we express the absolute figures in per cents. of the number of shells examined; comparing the two species there are :—

	Arca burnesi.	*Arca theobaldi.*
Var. *rotuntada* .	21·15 %	86·66 %
Var. *media* . .	66·34 %	13·33 %
Var. *elongata* . .	12·50 %	Nil.

The valves are therefore transversely oval, but less elongated than those of *Arca* (*Anomalocardia*) *burnesi*, the length still exceeding the height considerably; both are ventricose, the point of highest inflation being below the umbo. The thickness of the united valves nearly equals and in some cases exceeds the height.

The umbos are inflated, but depressed, prosogyric, pretty close to each other and situated near to the anterior extremity of the cardinal margin. The pedal region is very short, rounded, the siphonal one elongated, somewhat expanded. The anterior margin, which forms an obtuse angle with the cardinal margin, passes in

a wide sweep into the gracefully rounded ventral margin, which in its turn gradually passes into the rounded posterior margin, the latter forming a very obtuse angle with the cardinal margin. The cardinal margin is rectilinear, long, but considerably shorter than the greatest length of the shell.

Ligamental area long, narrow, concave, always provided with some deeply engraved angular ligamental grooves.

Hinge consisting of numerous lamellar teeth, of which those at the anterior and posterior extremity are obliquely inclined, those in the middle standing perpendicular to the cardinal margin.

Muscular scars and pallial impression ill seen, but apparently the same as in the former species. Margins deeply crenulated.

Like the former species, both valves differ in the ornamentation, which consists of about 26 to 28 radiating angular ribs, a smaller number not being observed. As in the former species, the ribs of the right valve are broader than the interstices, while the reverse takes place on the left valve.

On the left valves the ribs appear like strings of beads, by the deep, very regular, closely set concentric notches; numerous and regular concentric lines are observed in the interstices. The largest specimen exhibits in addition a feature of which I, however, do not know whether it is general or not; the anterior ten ribs show towards their ventral extremity a slightly indicated longitudinal furrow, which with increasing size of the valve would certainly tend towards bifurcation.

On the right valve all the ribs bear the granules as the result of the notching, although the notches are wider and shallower than on the left valve. The interstices are provided with the same regular, fine concentric striæ.

Geological occurrence.—

Zone of ***Arca theobaldi***, Kama.

Remarks.—It was with great reluctance that I gave a new name to this species which is so very similar to ***Arca*** (***Anomalocardia***) ***burnesi***, that the greatest difficulty exists in distinguishing isolated left valves of both. However, the following reasons, which I think decisive enough, have led me to a specific separation of both.

1. The shape of ***Arca*** (***Anomalocardia***) ***theobaldi*** is generally less elongate than that of ***Arca*** (***Anomalocardia***) ***burnesi***, as has been proved by a series of careful measurements.

2. On the right valve of ***Arca*** (***Anomalocardia***) ***theobaldi*** all the ribs are notched, exhibiting similar granules as those of the left valve, while in ***Arca*** (***Anomalocardia***) ***burnesi*** only the six anterior ribs are notched, the remainder being smooth.

3. On the left valve of ***Arca*** (***Anomalocardia***) ***theobaldi*** all the ribs are notched, exhibiting a granular appearance, while in ***Arca*** (***Anomalocardia***) ***burnesi*** the posterior five or six ribs remain smooth.

Though perhaps not too much weight might be attached to No. 1, the reasons under Nos. 2 and 3 are decisive. As both species never occur together, it is obvious that one is the descendant of the other, and as ***Arca*** (***Anomalocardia***) ***theobaldi***

occurs in higher beds, the tendency of evolution is quite clear. In the older species only a few ribs of the left valve were granular, the majority being smooth, while in the right valve all the ribs were granular, barring the last five or six. In the younger species all ribs on both valves are granular.

The tendency is, therefore, towards the formation of granular radiating ribs and this indicates the direction in which we have to look for the present living relatives. It is almost unquestionable that ***Arca* (*Anomalocardia*) *granosa***, Reeve, is the descendant of ***Arca* (*Anomalocardia*) *burnesi***, although a complete chain is not established yet. The obscure bifurcation on the anterior ribs of the left valve of ***Arca* (*Anomalocardia*) *theobaldi*** apparently indicates the direction in which some other younger species have branched off.

ARCA (ANOMALOCARDIA) THAYETENSIS, spec. nov., Pl. VI, fig. 2, *a-c*.

MEASUREMENTS.

	Length.	Height.	L/H.
Right valve	34·2 mm.	21·0	1·63

The shell is equivalve, transversely oval in shape, considerably longer than high; the index L/H is therefore moderately high, but as only a single valve could be measured, its amplitude of variation is not known; the shell is moderately inflated and rather inequilateral.

The umbo is inflated but strongly depressed, situated much in front of the middle line.

The pedal region is short, obliquely rounded, the siphonal region elongate, broadly expanded but truncated.

The anterior margin, which forms a very obtuse angle with the cardinal margin, is oblique, broadly rounded, and passes gradually into the long, convex ventral margin, the posterior margin is straight, oblique, forming a very obtuse angle with the cardinal margin, and a pointed angle, the corner of which is broadly rounded off, with the ventral margin.

Cardinal margin long, straight; the anterior portion much shorter than the posterior one.

An obtuse keel runs from the umbo towards the posterior corner, gradually becoming more effaced in ventral direction; behind it the surface is slightly concave.

The ornamentation consists of 40 to 41 flat, angular radiating ribs, separated by linear interstices of about one-third their own breadth. Area apparently very narrow, margins crenulated.

Hinge and internal characters not observed.

Geological occurrence.—

Horizon unknown. Thayetmyo.

Remarks.—This species bears a close resemblance to ***Arca* (*Anomalocardia*) *metabistrigata***, but is easily distinguished from that species by a flatter, broadly

oval shell, but particularly by the character of the ornamentation. In *Arca (Anomalocardia) metabistrigata* the anterior ribs are bifurcated, while no such feature is noticeable in *Arca (Anomalocardia) thayetensis*, the ribs remaining simple throughout. As none of the other species here described can be compared to it, it will have to be seen whether any similar species has been described either from Western India or Java.

Arca larkhanensis, d'Arch., which exhibits broad flat ribs separated by narrow interstices, differs by its less elongate shape, having apparently a very low index; in addition the umbo is high and not depressed, the area broad.

Much closer related seems *Arca rustica*, Mart., from Java, a species which is also distinguished by broad flat ribs separated by narrow interstices; as in addition to this character the general shape of the shell is much the same, I was first inclined to identify the species from Burma with that from Java. Professor Martin states, however, in the description that *Arca rustica* has only 25—27 ribs; therefore a much smaller number than observed in *Arca thayetensis*, the interstices of which are decussated, while they are apparently smooth in *Arca rustica*. Martin further states that the shell is thick, while *Arca thayetensis* has unquestionably a thin shell. These differences seemed to me sufficient to establish a new species, although there is unquestionably a close relationship between them.

Among the living species I find that *Arca gubernaculum* from the Philippines is unquestionably the closest relative. In fact, the similarity between both species is so great, that I felt inclined to identify the Miocene species with the recent one; both have the same kind of ornamentation, of flat simple ribs, separated by narrow interstices, but what is equally important, the same shape of shell exhibiting a very short pedal and an elongate broadly expanded siphonal region, the number of ribs 32—33 is, however, smaller, and according to the description they were slightly serrated. Another close relative seems to be *Arca japonica*, Reeve, which agrees well with regard to general shape and ornamentation, but as this species is said to be very inequivalve, a feature for which we have no proof in the fossil species, I think it is inadmissible to draw further conclusions without having a specimen for comparison.

It is sufficient to have drawn the attention to the fact that the nearest relatives of *Arca thayetensis* live nowadays in the eastern seas, and that it represents a type extinct among the present fauna of the Indian Ocean.

ARCA METABISTRIGATA, spec. nov., Pl. VI, fig. 13, *a-i*.

MEASUREMENTS.

Length.	Height.	Thickness.	L/H.
30·0 mm.	18·6 mm.	9·6 mm.	1·61.

The shell is equivalve, elongate, irregularly trapezoidal in shape, the length exceeding the height considerably; the index L/H is therefore apparently high; it is strongly inflated, the thickness of both valves being a little larger than its height and rather inequilateral.

The umbo is inflated, strongly prosogyric, a little flattened on the top, situated in front of the middle line, rather close to the anterior margin.

The pedal region is very short, rounded, the siphonal region very much longer, slightly expanded and truncated.

The anterior margin is slightly convex, almost straight, forming an angle of a little over 90° with the cardinal margin; the ventral margin is oblique, slightly convex, not sinuated, abruptly turned in dorsal direction at its anterior extremity; the posterior margin is straight, oblique, forming a very obtuse angle with the cardinal margin and a pointed angle, the corner of which is rounded off, with the ventral margin. Cardinal margin long, straight, inequilateral, the anterior portion being much the shorter.

A keel which is sharp at the beginning, but becomes more indistinct in ventral direction, runs from the umbo towards the posterior corner; behind it the surface slopes moderately and is slightly concave.

The ligamental area is lanceolate, very long and inequilateral; the anterior portion being short, but a little broader than the long, narrow, posterior portion; it is bordered by a sharp keel, slightly concave, and carries a few undulating cartilage grooves.

The hinge is long, consisting of numerous very small teeth, those at the anterior and posterior extremity being obliquely set, and just a little larger than the others.

The ornamentation consists of radiating angular ribs, uniformly covering the whole surface of the shell, but owing to the position of the umbo the anterior ribs are much shorter than the posterior ones; on each valve there are 36 ribs which are angular in section, and flat on the top, separated by interstices of about the same breadth as the ribs at the ventral margin, but considerably narrower at the umbonal region. During the nealogic stage, as is demonstrated by the umbonal region, all the ribs are simple, undivided, rather broad, separated by linear interstices; after a certain size has been reached, a fine sharp furrow appears on some of the anterior ribs, and with increasing size the furrow deepens; the ribs are split lengthwise, while gradually some more ribs are affected in the same way. On the full grown shell the anterior 13 to 16 ribs are deeply bifurcated and appear to be composed of a pair of filiform, rounded ribs separated by rather a broad interstice; the posterior 20 ribs remain undivided throughout, and increase slightly in breadth towards the posterior keel, decreasing again towards the cardinal margin. There are also numerous closely set striæ of growth which particularly appear in the interstices.

Muscular scars well marked, the anterior one round, smaller than the large quadrilateral posterior one. Pallial impression well marked, close to the margin.

Margin deeply crenulated, crenulations increasing in size and depth from the anterior margin towards the posterior corner, decreasing from there towards the cardinal margin.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Remarks.—Only one, but completely preserved specimen has come under examination, and though it may perhaps be argued that the specific features cannot be deduced with certainty from a single species only, particularly if there are other closely allied species, I think the specimens exhibit enough characteristic features to allow for some important conclusions.

Its nearest relative is *Arca bistrigata*, Dunker, and at the first glance the two species seem to be identical; on further examination it will, however, be seen that there are some decided differences; in order, however, to avoid unnecessary repetitions the relationship of both species will be discussed after the description of *Arca bistrigata*.

ARCA BISTRIGATA, Dunker, Pl. VII, figs. 1, 1*a*, 2, 2*a*.

1857. *Arca bistrigata*, Dunker, Conch. p. 87, pl. 30, figs. 4-6.
1887. " " Martin, Beiträg. zur Geolog. Ost. Asiens und Aust., Vol. III, p. 256, pl. XIII, fig. 260.
1895. *Dophnoderma costata*, Noetling, Mem. Geolog. Survey of India, Vol. XXVII, Pt. I, p. 7, pl. I, figs. 4-4*a*.

MEASUREMENTS.

	Length.	Height.	L/H.
Left valve .	320 mm. .	213 mm.	150

Though not unfrequent, well preserved valves are rare; in fact, not a single intact specimen has come under examination and the characters had to be made out from combination of several specimens.

The shell is equivalve, elongate, irregularly trapezoidal in shape; the length exceeding the height to some extent, though the index L/H is not very large; as far as can be judged, the valves attained a size which was not much under that of the living specimen I have for comparison, but the majority of the fossil specimens are smaller; the shell is strongly inflated and rather inequilateral.

The umbo is strongly tumid, but somewhat flattened at the top, situated considerably in front of the middle line, rather close to the anterior margin.

The pedal region is short, rounded, the siphonal region elongate and broadly expanded. The anterior margin is short, slightly convex, almost straight, forming nearly a right angle, the corner of which is broadly rounded off, with the ventral margin; the latter is rather long, slightly sinuated in the middle, turning abruptly in dorsal direction at its posterior extremity and passing into the oblique, convex posterior margin; the cardinal margin is long, straight, very inequilateral; the anterior, shorter portion forming a slightly obtuse angle with the anterior margin, the posterior, longer portion, a very obtuse angle with the posterior margin.

A slightly indicated, broadly rounded, keel runs from the umbo towards the posterior corner, and behind it the surface is slightly concave.

The ornamentation consists of 30 radiating ribs, uniformly covering the whole surface, but owing to the position of the umbo the anterior ones are much shorter than the posterior ones; the ribs are generally speaking broad, flat and separated by interstices smaller than their own breadth; except the hindmost 10 or 12, all ribs are split up the whole of their length by a fine, deep furrow; each rib appears therefore to consist of two finer ones, which are particularly towards the umbonal region a little granulose.

The ligamental area is apparently long and very narrow. Characters of the hinge not observed, muscular scars rather large, deeply sunk.

Geological occurrence.—

Zone of ***Mytilus nicobaricus***, Singu.
Zone of ***Meiocardia metavulgaris***, Singu.
Zone of ***Cancellaria martiniana***, Minbu.
Zone of ***Paracyathus caeruleus***, Yenangyat.
Zone of ***Anoplotherium birmanicum***, Yenangyoung.

Remarks.—As already pointed out, I have convinced myself from comparison with the living ***Arca bistrigata***, Dunker, from the Andaman Islands, that there is no difference between the recent and the Miocene specimens.

The only difference, if it may be so called, I was able to discern was a higher index L/H in the living species, amounting to 1·98; there are, however, some of the fossil specimens which must have had an index quite as high as this, and I would therefore not put too much stress on this difference; another difference would be, that in the living specimen the undivided posterior ribs are very much broader than the bifurcated anterior ones, a feature which though indicated in the fossil specimens is not quite so conspicuous. I did not, however, consider these slight differences sufficient for a specific separation.

The only species which could be compared to ***Arca bistrigata*** is ***Arca metabistrigata***, and it will be admitted that the similarity between both species is very great; there is, however, a good distinguishing feature, the older ***Arca metabistrigata*** has a larger number of ribs, *viz.*, 36, of which only the anterior 13 to 16 are split up lengthwise, while the majority, that is to say, the 20 posterior ribs remain undivided. In ***Arca bistrigata*** just the opposite takes place; the majority of ribs is split up, and the minority, the posterior 6 to 8 ribs, remain undivided.

In the description of ***Arca metabistrigata*** I pointed out that during the nealogic stage of ***Arca bistrigata***, when only a few of the anterior ribs were bifurcated, this species resembled so closely the older species that there is apparently no doubt that it directly descended from it; the tendency of evolution would therefore be directed towards the bifurcation of the primarily simple ribs; bifurcation beginning with the foremost ribs and gradually extending in posterior direction.

The Eocene ancestor of ***Arca bistrigata*** would therefore be a transversely elongate rhomboidal shell, having a narrow area, a very slightly sinuated ventral margin, and numerous flat, rather broad, simple ribs, separated by linear interstices; we might call this hyphothetical species ***Arca protobistrigata*** and the line of evolution would therefore be:—

Arca protobistrigata, Older Tertiaries

|

Arca metabistrigata, Miocene

|

Arca bistrigata, Miocene and recent.

ARCA (ANOMALOCARDIA) OLDHAMIANA, spec. nov., Pl. VI, fig. 3, *a-b*.

MEASUREMENTS.

	Length.	Height.	L/H.
Left valve	. 27·0 mm.	. 17·4 mm.	. 1·55

Only an isolated left valve has come under examination, but it affords sufficiently characteristic features to be determined. The shell was most probably slightly inequivalve, inasmuch as left and right valve differed somewhat with regard to their ornamentation. It is transversely oval in shape, the length being somewhat in excess of the height, the index L/H is therefore not very high ; it is moderately inflated and rather inequilateral.

The umbo is slightly inflated, strongly prosogyric, and situated pretty close to the anterior margin.

The pedal region is very short, obliquely rounded off ; the siphonal region is broadly expanded and truncated.

The anterior margin is obliquely rounded, forming a very obtuse angle with the cardinal margin, and passing gradually into the convex, but somewhat oblique ventral margin ; the latter is strongly turned in dorsal direction at its posterior extremity, and passes gradually into the slightly convex anteriorly inclined, posterior margin which forms a very oblique angle with the cardinal margin ; cardinal margin long, straight, inequilateral, the posterior portion being the shorter.

The ornamentation consists of about 25 rounded radiating ribs, separated by narrow concave interstices ; the ribs are rather strong, and each bears on its top a shallow furrow, the edges of which are sometimes sharp, assuming the shape of secondary filiform ribs on the primary ones.

Area apparently very narrow. Hinge and internal characters not observed.

Geological occurrence.—

Zone of *Pholas orientalis*, Thayetmyo.

Remarks.—At the first glance this species might be mistaken for either *Arca* (*Anomalocardia*) *burnesi* or *Arca* (*Anomalocardia*) *theobaldi*, as its shape is something very similar to that of those two species. The ornamentation is, however, different, as both species exhibit granular ribs, while the ribs of the species under examination are smooth, except for the concentric striae of growth, but furrowed on the top.

No similar species has been described by either Professor Martin or Messrs. d'Archiac and Haime. Any of their species which might be similar in shape, differ widely with regard to ornamentation.

I am unable to find any living relative, as the species is not sufficiently well preserved for such a purpose; it seems, however, probable that it represents a type extinct in the present fauna of the Indian Ocean.

ARCA (ANOMALOCARDIA) YAWENSIS, spec. nov., Pl. VI, figs. 4, *a-e*, 5, *a-e*, 6.

MEASUREMENTS.

Length.	Height.	Thickness.	L/H.
(*a*) Right valve.			
18·6 mm.	16·0 mm.	8·4 mm.	1·16
18·0 „	17·8 „	8·5 „	1·01
17·8 „	15·5 „	7·6 „	1·14
17·0 „	15·0 „	8·0 „	1·13
(*b*) Left valve.			
17·2 mm.	16·5 mm.	7·4 mm.	1·04

The shell is almost circular in shape, there being no great difference between length and height as is sufficiently illustrated by the above figures, where the index L/H sinks as low as 1·01; the valves are sub-equilateral, strongly inflated, the thickness exceeding the height in several instances. The umbo is inflated, incurvated and strongly prosogyric, being a little in front of the middle line. Pedal and siphonal regions are nearly equal in size, the former being rounded, the latter truncated. The anterior margin forms an obtuse angle with the cardinal margin and passes in a broad sweep into the strongly curved ventral margin, which is hardly set off against the curved posterior margin, which in its turn forms an obtuse angle with the rectilinear cardinal margin. An obtuse keel, which in fact is only well marked during the nealogic stage, runs from the umbo towards the posterior corner, and while in front of it the shell is uniformly and strongly inflated, it is slightly concave behind it.

The hinge consists of numerous closely set teeth of which the older, *i.e.*, the central ones, are very small, perpendicular to the cardinal margin, while the younger, *i.e.*, the marginal ones, are larger and obliquely set.

The ligamental area is long, narrow in its posterior part up to the umbo, largely expanded in front of it. A few strongly engraved cartilage grooves are visible.

The muscular scars are strongly marked, the posterior one much larger than the anterior one, distinguished by a smooth surface and a dark brown colour from the remainder of the inner surface. The pallial impression is strong, rather distant from the deeply crenulated margin.

The ornamentation consists of 29 very regular, radiating ribs; these ribs are simple, angular, flattened on the top, perpendicular at the sides and were apparently smooth; at least the state of preservation does not allow to say whether they might not have been granular, but if so, the granulations must have been very fine and easily rubbed off. The interstices were of the same breadth as the ribs, perhaps slightly broader on the right valve, while in this case the reverse should take place on the left one; the difference is, however, hardly perceptible, so that to all appearances the ornamentation of both valves is the same. The interstices were covered with numerous, very fine concentric lines.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—This species is easily distinguished from all the others by its orbicular shape and the character of the ornamentation.

It has a similar sort of ribs as *Arca* (*Scapharca*) *peethensis*, but is readily distinguished by its circular shape; on the other hand it agrees in shape with *Arca* (*Anomalocardia*) *myoënsis*, but this species apparently never attained the size of *Arca* (*Anomalocardia*) *yawensis*, and the ribs although being the same in number, differ materially by their granulated appearance, at least on the left valve. It is obvious that *Arca* (*Anomalocardia*) *yawensis* stands in the same relationship to *Arca* (*Anomalocardia*) *myoënsis* as does *Arca* (*Anomalocardia*) *burnesi* to *Arca* (*Anomalocardia*) *theobaldi*. In the latter instance we have seen that the first named species exhibits only a few anterior granular ribs on the right valve, while in the second species the granulations extended all over the ribs of the right valve.

In this instance we notice that no granulations can be noticed in *Arca* (*Anomalocardia*) *yawensis*, while the ribs of the left valve are strongly granulated in *Arca* (*Anomalocardia*) *myoënsis*.

The nearest species allied to it would, perhaps, be *Arca larkhanensis*, d'Arch., which is, however, easily distinguished by the character of the ornamentation.

No living relative of this species could be found which therefore represents a type extinct among the fauna of the Indian Ocean, but which probably had its nearest relative in the fauna of the Indian Eocene.

ARCA (ANOMALOCARDIA) MYOËNSIS, spec. nov., Pl. VI, figs. 7, *a-c*, 8, *a-c*, 9, *a-c*, 10, *a-f*, 11, 11*a*, 12.

MEASUREMENTS.

(*a*) Right valve.

	Length.	Height.	Thickness.	L/H.
1.	16·9 mm.	13·5 mm.	6·5 mm.	1·25
2.	13·0 „	10·7 „	5·0 „	1·21
3.	12·3 „	10·3 „	4·1 „	1·20
4.	12·0 „	10·9 „	4·7 „	1·10
5.	8·6 „	7·1 „	3·0 „	1·21

(*b*) Left valve.

	Length.	Height.	Thickness.	L/H.
1.	16·0 mm.	13·0 mm.	6·3 mm.	1·23
2.	15·0 „	13·1 „	6·2 „	1·14
3.	14·3 „	12·8 „	5·9 „	1·11
4.	12·2 „	10·6 „	5·0 „	1·15
5.	12·2 „	10·5 „	4·8 „	1·16
6.	11·7 „	10·4 „	4·1 „	1·12
7.	11·4 „	9·4 „	? „	1·21

The shell is almost orbicular in shape, the height only slightly exceeding the length; the index L/H is therefore very small, and among the specimens under examination it does not exceed 1·25, but sinks as low as 1·10. The valves are subequilateral, a little oblique and strongly inflated, the thickness of both valves being

nearly equal to the height, though it seems that the smaller valves are a little flatter, inasmuch as the thickness remains considerably below the height. The umbo though inflated is low and strongly prosogyric, situated somewhat in front of the median line. Pedal and siphonal regions do not much differ, though the latter is somewhat longer and slightly concave towards the cardinal margin. The anterior margin is broadly rounded, passing in a broad sweep into the rounded ventral margin, which in its turn gradually passes into the short, straight, posterior margin. The cardinal margin is considerably smaller than the greatest length of the valve, and forms an obtuse angle with both anterior and posterior margins.

The hinge consists of numerous closely set teeth, the older ones of which are very small, and perpendicular to the cardinal margin; the younger, *i.e.*, the outer ones, are a little larger and obliquely set.

The ligamental area, as seen from above, seems to be divided into two regions; the posterior one is long and narrow, bordered by a straight line which reaches from the umbo to the posterior extremity; the anterior one is short but broad, bordered by a curved line extending from the umbo to the anterior extremity. A few cartilage grooves visible.

The muscular scars strongly marked; the posterior slightly taller than the anterior one. Pallial impression not well marked, close to the deeply crenulated margin.

The ornamentation consists of 24 to 25 radiating ribs; these ribs are very uniform in strength, simple, and separated by interstices which are slightly broader than the ribs on the right valve, while the reverse takes place on the left valve. The difference is, however, so slight, that it is hardly perceptible. On the left valve all the ribs appear like strings of beads by very regular, rather deep concentric notches; it appears, however, that during the nealogic stage the ribs were smooth; the interstices are covered with numerous, fine concentric lines. On the right valve only the anterior five or six, as well as the posterior three or four ribs were granulated; the remainder exhibited only slight indications of the notches; the interstices are covered with fine, rather distant concentric striæ.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Remarks.—This species might only be mistaken for *Arca* (*Anomalocardia*) *yawensis;* from all the others it is easily distinguished by the orbicular shape of the valves; from the former it differs chiefly by a more uniformly inflated shell, the concavity on the posterior region being much less developed, and particularly by the granulated ribs of the left valve. As the other relations have been mentioned in the discussion of *Arca* (*Anomalocardia*) *yawensis* it is unnecessary to repeat them here.

No living or fossil relative of this species could be discovered, which represents a type extinct among the fauna of the Indian Ocean.

ARCA (ACAR?) NANNODES, K. Martin, Pl. VII, figs. 3, *a-f*, 4, *a-e*.

1883—87. *Arca nannodes*, K. Martin, Beiträg. zur. Geolog. Ost. Asiens und Aust., Vol. III, p. 256, pl. XIII, fig. 259.

MEASUREMENTS.

(*a*) Right valve.

	Length.	Height.	Thickness.	L/H.
1.	24·8 mm.	12·3 mm.	5·4 mm.	2·01
2.	19·5 „	11·3 „	5·0 „	1·72
3.	18·6 „	9·6 „	4·3 „	1·93
4.	14·0 „	8·3 „	2·9 „	1·70
5.	13·3 „	7·3 „	3·0 „	1·78
6.	7·2 „	4·2 „	1·4 „	1·71

(*b*) Left valve.

	Length.	Height.	Thickness.	L/H.
1.	18·8 mm.	10·3 mm.	4·0 mm.	1·82
2.	13·7 „	7·7 „	3·5 „	1·78
3.	11·5 „	6·7 „	2 „	1·71

The shell is always much longer than high, the index L/H varying from 1·70 to 2·01, that is to say, the length of the largest specimens is twice its height. The shape is nearly very rectangular; the valves are rather flat and inequilateral; the umbo is little inflated, very depressed and situated in front of the middle line, but somewhat behind the first third part of the length. The pedal region is short, attenuated; the siphonal one broad and elongated, but a little concave. The anterior margin, which forms a pointed angle with the hinge margin, is obliquely curved backwards and slightly sinuated, just below the hinge margin; it passes gradually into the straight ventral margin which is, however, slightly sinuated in the middle; the straight posterior margin joins both the cardinal margin and the ventral margin at an angle of 90; the junction is, however, rounded off in the latter, while it forms a sharp corner in the former case. The cardinal margin is rectilinear, parallel to the ventral margin, representing the greatest length of the shell. A hardly perceptible depression runs from the umbo towards the ventral margin, producing a slight sinuation.

The ligamental area is very long, but also very narrow, widening out a little just in front of the umbo. A few cartilage grooves on its posterior part.

The hinge is long and consists of about 60 small lamellar teeth which decrease in size from both sides towards the centre; the posterior two-thirds of the teeth are obliquely inclined backwards; a few, the smallest, just below the umbo are perpendicular; the anterior third is slightly inclined forwards.

Muscular impressions ill seen; pallial impression entire, close to the crenulated margin.

Both valves are covered with about 30 radiating ribs, showing an angular section, flat on the top and perpendicular on the sides, but both valves differ in that regard that the ribs of the right valve are narrower than the interstices, while the reverse takes place on the left valve. On the pedal region of the shell the ribs are broadest near the hinge line, and gradually decrease in thickness towards the ventral sinus; the middle of the sinus is marked by the thinnest ribs, and thence they increase again till they have reached the same strength as they were in front on the siphonal region. In this regard the ribs on both valves

are the same, but owing to the strength of the ribs, this feature is much more marked on the left than on the right valve. On the left valve the ribs are crossed by numerous concentric lines producing regular, concentric closely set wrinkles on the top of the ribs, and fine lines in the interstices. On the right valve the ribs were apparently free of the wrinkles, or they were at least only feebly marked and apparently chiefly on the anterior ribs, while the interstices are marked with numerous, sometimes a little irregular, concentric striæ.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Remarks.—Its rectangular shape distinguishes *Arca* (*Acar*?) *nannodes* at once from all the other species, so that there exists no doubt as to its specific identity even in small specimens.

No similar species has hitherto been described from the Indian Tertiaries, but Martin describes from Java a species under the name of *Arca nannodes* which is apparently identical with the specimen from Burma. The shape is exactly the same, but there seems to be a slight difference with regard to the ribs, inasmuch as Martin states that the middle ones are deeply bifurcate. Owing to the state of preservation I have not been able to observe this feature in any of my specimens, but there are indications which render its presence highly probable.

It is remarkable that none of the living species comes anywhere near to *Arca nannodes*, a type which has apparently died out, among the fauna of the Indian Ocean.

Arca (Barbatia) bataviana, K. Martin, Pl. VII, figs. 5, *a-f*, 6, *a-d*, 7, 7*a*, 8, *a-b*.

1883—87. *Arca bataviana*, K. Martin. Beiträg zur. Geol. Ost. Asiens. und Aust., Vol. III, p. 253, pl. XII, figs. 256 and 257.

Measurements.

a. var. *normalis.*

Right valve.

	Length.	Height.	L/H.
1.	7·0 mm.	5·0 mm.	1·40
2.	6·5 „	4·1 „	1·58

(*b*) Left valve.

	Length.	Height.	L/H.
1.	6·8 mm.	4·7 mm.	1·44
2.	6·8 „	4·7 „	1·44
3.	6·7 „	4·1 „	1·63

b. var. *carinata.*

(*a*) Right valve 8·1 mm. . 5·0 mm. . 1·60

(*b*) Left valve 6·8 mm. . 4·4 mm. . 1·64

This is a small species which apparently does not attain a size of much over 8 mm., its shape is trapeziform, transversely elongated, the length always exceeding the height considerably, as is indicated by the index L/H. The shell is rather flat and subequilateral, the umbo being slightly in front of the median line. The umbo is pointed, depressed, somewhat flattened on the top and incurvated. Pedal region short, rounded; siphonal one short, truncated. A very shallow hardly perceptible depression runs from the umbo towards the ventral margin; a keel which runs from the umbo to the posterior corner varies greatly in sharpness, in all specimens it is, however, well marked at the umbonal region; in some of the specimens it becomes rounded and disappears entirely, while in the var. *carinata* it remains well defined

and sharp throughout. Smooth ribs distinguish this species easily from all the others.

In front of the keel the surface is slightly but uniformly inflated, behind it it is deeply concave. The anterior margin which forms an obtuse angle with the cardinal margin is broadly rounded and passes under a rounded-off corner into the straight ventral margin; the straight but oblique posterior margin joins the former at a pointed angle, the corner being rounded off, and the latter at an obtuse angle. Cardinal margin straight, considerably shorter than the greatest length of the valve.

The hinge consists of not very many small lamellar teeth, which are arranged in a curved line, the anterior and posterior teeth which are obliquely set being the largest. Ligamental area long and narrow. Muscular scars comparatively large, but ill seen. Margin minutely crenulated. The ornamentation is the same in both valves and consists of numerous very fine, filiform radiating ribs, which are equidistant, but apparently much more closely set on the right than on the left valve. Towards the margin, finer ribs are intercalated in an irregular way between two primary ones. In some specimens, apparently the var. *carinata*, only numerous regular concentric ribs cross the radiating ones, producing a minute granule at the point of intersection.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Zone of *Pholas orientalis*, Thayetmyo.

Remarks.—It seems at first not very commendable that two, to all appearances very different varieties, should be included under a common name, but although my material is very scanty I can fully corroborate Prof. Martin's statement. The chief difference rests in the formation of the keel, which is very sharp in the var. *carinata*, giving it quite a peculiar appearance. In the normal variety, or at least that form which I consider as the normal variety, the keel is only visible at the umbonal region, afterwards it becomes effaced and the posterior region which has been so neatly set off in the var. *carinata* becomes merged into the general surface.

It should be mentioned, at least as far as can be judged from the scanty material, that the specimens from Burma show the same peculiarity as those from Java, namely, that chiefly the elongated specimens are carinated.

The nearest relatives of this speices are unquestionably *Arca symmetrica*, Reeve, and *Arca sculptilis*, Reeve, two species living nowadays at the Phillipines; the former has also been found near Singapore. As I have no specimens for comparison, and as Reeve's figures are not sufficient for such minute distinction I am unable to say to which of the two species, which apparently resemble each other greatly, *Arca bataviana* is closer related, the more so as perhaps *Arca tenebrica*, Reeve, and *Arca navicella*, Reeve, the latter probably corresponding to the var. *carinata*, should also be taken into consideration. It is noticeable that most of these species, one of which is probably the descendant of *Arca* (*Barbatia*) *bataviana*, live nowadays in eastern seas, while this type is extinct among the present fauna of the Indian Ocean.

ARCA (SCAPHARCA) PEETHENSIS, d'Archiac and Haime, Pl. VII, fig. 9, *a-c*.

1853. *Arca peethensis*, d' Archiac and Haime, Des. anim. foss. du groupe num. de l' Inde, p. 263, pl. XXII, figs. 2*a*, 3, 6.

MEASUREMENTS.

(*a*) Right valve.

Length.	Height.	Thickness.	L/H.
30·2 mm.	24·2 mm.	11·3 mm.	1·24
26·7 „	24·0 „	10·3 „	1·11
25·3 „	21·3 „	9·3 „	1·14
16·3 „	13·3 „	5·6 „	1·14

(*b*) Left valve.

Length.	Height.	Thickness.	L/H.
55·3 mm.	? mm.	? mm.	?
24·7 „	18·5 „	8·3 „	1·33
19·2 „	16·2 „	6·2 „	1·17
18·3 „	14·3 „	5·6 „	1·28
18·4 „	14·4 „	5·6 „	1·27

The length of the rhomboidal shell exceeds the height to a small extent as will be seen from the above indices L/H ; the difference being however not very large. Both valves are strongly gibbous, the point of highest inflation being below the umbo in the posterior region of the shell. The umbo is low and depressed, somewhat flattened on the top, situated close to the anterior margin. A strong, though obtuse, keel runs from the umbo to the posterior corner, in front of which the valve is uniformly inflated, while behind it the surface dips steeply, and is slightly concave. The pedal region is very short, contracted; the siphonal one broadly expanded. The anterior margin is shortly rounded and forms nearly a right angle with the hinge line passing in a broad sweep into the nearly straight, but very oblique ventral margin. The posterior margin which is slightly curved, forms an oblique angle with the cardinal margin, and a right one with the ventral margin, the corner of junction being rounded off. The ligamental area is long, and comparatively broad, cartilage grooves numerous.

Hinge long, extending over the whole length of the hinge margin, and consisting of numerous teeth, the central ones of which are very small and perpendicular to the hinge line. A very few at the posterior and anterior extremity are obliquely directed, and exceed the others greatly in length.

Anterior muscular scar rather small, posterior one large; pallial impression strong, close to the margin, which is deeply crenulated. The surface is covered with 39 to 40 radiating ribs, which are somewhat broader than the interstices on the left valve, while they are slightly narrower on the right valve, though the difference is hardly perceptible. The ribs are of uniform strength, flat on the top, angular and are apparently smooth, at least for the greater part of their length; on the anterior ribs of the left valve and probably also on the posterior ribs, a longitudinal punctured line was engraved indicating an indistinct bifurcation; the median ribs appeared indistinctly bipartite towards their ventral extremity. With regard to the right valve I am unable to say whether it exhibited the same feature or not; if I am, however, not mistaken, only a few of the anterior ribs possessed the longitudinal furrow.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.

Zone of *Pholas orientalis*, Thayetmyo.

Remarks.—The specimens which have come under examination are all so much

worn, that I had the greatest difficulty in dicovering the minute ornamentation of the punctuate line on the anterior ribs. I have, however, satisfied myself that this is actually the case, and as the shape, the number and the general character of the ribs fully agree with the description Messrs. d'Archiac and Haime give of this species, I have not hesitated in identifying the specimens from Burma with *Arca peethensis*, d'Archiac and Haime.

From all the other *Arca* (*Scapharca*) *peethensis* is easily distinguished by its rhomboidal shape and its seemingly smooth, very uniform ribs.

No living relative of this species could be discovered among the fauna of the Indian Ocean, and it is undoubtable that it represents an extinct type, which probably had its nearest relatives among the fauna of the Indian Eocene.

2. Genus : PARALLELIPIPEDUM, Klein.

This peculiar genus is said by Messrs. Adams [1] to include two living species only, *viz.*, *Arca* (*Parallelipipedum*) *semitorta*, Lmk., and *Arca* (*Parallelipipedum*) *tortuosa*, Linné, a view which has been accepted by most authors. Fischer [2] correctly remarks that a third species, *Parallelipipedum kurrachensis*, d'Archiac and Haime, must be added to this number, but as may here be stated, this species does not occur in the Eocene, as Fischer was led to suppose, but in the Gajian bed of Western India. *Parallelipipedum prototortuosum* from the Miocene of Burma comes in as the fourth species. So far as we know the fossil representatives are restricted to the Miocene of India and Burma, while the living ones inhabit the Chinese seas.

The living *Parallelipipedum tortuosum* comes closest of the two to the fossil *Parallelipipedum prototortuosum*, but it is easily distinguished by its larger size and by the serrated keel of the posterior region. If I am, however, not very much mistaken, at least to judge from Reeve's figure, as I have no specimen of *Arca tortuosa* for comparison, the young specimens of this species, in which the keel was not so markedly developed as in the full-grown individual, exhibit a remarkable likeness to the Miocene species, in particular with regard to shape and the difference of sculpture of anterior and posterior region. In the living *Arca tortuosa*, as well as in the fossil *Parallelipipedum prototortuosum* the pedal region exhibits fine, closely set filiform ribs, which become nearly effaced on the siphonal region.

Taking all the chief features into consideration I dare say that I am not very much mistaken if I consider *Parallelipipedum prototortuosum* as the predecessor of the living *Parallelipipedum tortuosum*. This genus would have first made its appearance in the Miocene of Western India and Burma, and having died out in the Indian Ocean, is restricted at the present time to the China Seas.[3]

[1] Genera of Recent Mollusca, page 538.

[2] Manuel de Conchologie, page 976.

[3] While this is in the press I found among the fossils from the Mekran coast collected by Dr. Blanford specimens which seem to be identical with *Parallelipepidum prototortuosum* ; this species has therefore existed up to quite recently in the Persian Gulf.

PARALLELIPIPEDUM PROTOTORTUOSUM, spec. nov., Pl. VII, figs. 10, *a-f*, 11, *a-f*.

MEASUREMENTS.

(*a*) Left valve.

	Length.	Height. (*A*)	Height. (*B*)	L/H.
1.	34·7 mm.	22·2	21·0 mm.	1·56
2.	34·0 „	20·0	18·4 „	1·79
3.	33·9 „	21·3	19·5 „	1·59
4.	33·6 „	23·0	21·9 „	1·46
5.	33·3 „	19·3	18·4 „	1·73
6.	32·4 „	18·9	17·8 „	1·72
7.	32·1 „	21·6	20·8 „	1·49
8.	31·9 „	20·0	18·5 „	1·59
9.	31·4 „	19·2	18·8 „	1·63
10.	31·4 „	19·3	17·1 „	1·62
11.	31·2 „	17·8	16·7 „	1·75
12.	29·7 „	17·6	16·7 „	1·70
13.	29·4 „	16·7	15·2 „	1·74
14.	29·1 „	16·8	15·1 „	1·73
15.	28·9 „	17·1	15·7 „	1·69
16.	22·8 „	14·8	13·4 „	1·54
17.	19·6 „	12·5	11·7 „	1·56
18.	16·0 „	10·9	10·3 „	1·47

(*b*) Right valve.

	Length.	Height. (*A*)	Height. (*B*)	L/H.
1.	?	24·7	23·4 mm.	?
2.	34·5 mm.	21·4	20·7 „	1·61(?)
3.	33·3 „	21·7	20·6 „	1·53
4.	33·0 „	19·3	18·5 „	1·71
5.	32·3 „	20·6	19·5 „	1·56
6.	31·3 „	16·7	16·5 „	1·87
7.	30·4 „	20·2	19·3 „	1·50
8.	30·3 „	18·5	18·0 „	1·63
9.	27·8 „	17·6	16·3 „	1·57
10.	28·7 „	16·5	16·0 „	1·74
11.	28·5 „	17·1	16·3 „	1·66
12.	27·0 „	17·8	16·7 „	1·52
13.	26·4 „	17·6	16·9 „	1·50
14.	26·1 „	15·1	14·4 „	1·72
15.	26·0 „	18·0	17·4 „	1·44
16.	25·3 „	16·4	15·9 „	1·54
17.	23·9 „	14·5	13·7 „	1·64
18.	22·9 „	14·3	13·7 „	1·60
19.	22·6 „	14·6	13·3 „	1·54
20.	21·9 „	15·0	13·8 „	1·46
21.	21·5 „	13·8	12·5 „	1·56

(*A*) Measured from posterior corner to umbo.
(*B*) Ditto ditto to hinge margin.

Shell subequivalve, inequilateral, quadrangular, twisted in a very peculiar way, covered with numerous fine radiating ribs.

(*a*) *Right valve.*—The right valve is always considerably longer than high; the above figures which have been taken from well preserved specimens only, prove that the index L/H varies considerably, the lowest figure observed being 1·46, the highest 1·75, that is to say, the length may vary from less than 1½ times to 1¾ times the height; the average being 1·62, eight of the above number being below, seven above the average, one only representing the average index.

It is therefore obvious that the shape of the valve is somewhat variable although the general outline remains the same. Roughly speaking, its shape is sub-quadrangular, but very inequilateral; the pedal region is short, rounded, the siphonal one broadly elongate and truncated. The rounded anterior margin, which forms nearly a right angle with the cardinal margin, passes gradually into the straight, but slightly sinuated central margin, which runs in an oblique direction forming an angle of about 20° with the cardinal margin. The posterior margin is straight, and forms an angle of about 90° with both cardinal and ventral margin, the corners being rounded off; the cardinal margin which is rectilinear nearly equals the greatest length.

The umbo is small, somewhat inflated and depressed, situated in the anterior

third of the length. The valve is moderately tumid in its anterior, slightly concave in its posterior region. A strong, but somewhat obscurely defined rounded keel accompanied in front by a shallow furrow, runs from the umbo towards the posterior corner, gradually flattening in ventral direction. The postero-ventral part of the valve is tongue-like, elongated and twisted inwards in such a peculiar way that seen from above, it forms an angle of about 60° with the cardinal line.

The ligamental area is very long and exceedingly narrow, exhibiting a few engraved lines. The hinge is strong and consists of numerous lamellar teeth arranged in two groups, which are lying in two different planes. The anterior group being the smaller, consists of about 18 teeth, decreasing in length in posterior direction, and being obliquely inclined forwards. The posterior group of about double the length contains 30 teeth inclined backwards and decreasing in size in anterior direction, the point where both sets meet being just below the umbo.

The surface is covered with numerous fine, filiform radiating ribs, separated by interstices of more than double the breadth ; their number is increased by the somewhat irregular intercalation of finer ribs in the broad interstices. Fine striæ of growth are seen all over the whole surface, but towards the margin they become coarse and closely set, rendering the ventral, but particularly the posterior margin lamellar.

The muscular scars are large, the pallial impression sharply defined, the edges levelled.

(*b*) *Left valve.*—In the left valve the index L/H varies from 1·44 to 1·87 ; the average being 1·59 ; although the length of the left valve may sink to less than 1½ times its height, it may rise to considerably more than 1¾ times its height ; the above figures seem to indicate that in the average the index L/H is a little smaller than in the right valve. Among the above specimens 9 are above and 11 below the average, which may perhaps account for the small discrepancy.

Of course the shape of the valve is variable, but seen from above it generally appears to be triangular owing to the strong twist of the anterior portion. The features of the margins are the same as in the right valve, but the left one is much more inflated, and the posterior keel broad but ill defined, as well as the depression in front of it is broader though shallower. Instead of the posterior portion of the valve being twisted as in the right valve the anterior one is so strongly twisted, that it forms sometimes nearly a right angle with the hinge line, the anterior group of teeth being nearly flat when seen from above.

The hinge and other internal features are the same as in the right valve.

The ornamentation consists of numerous filiform radiating ribs, which are, however, stronger than on the right valve, in such a manner that the ribs are broader than the interstices. The former become, however, nearly effaced on the posterior region, where they are only indistinctly seen. The intercalated finer ribs are well marked ; in the interstices numerous fine and very regular striæ are to be seen producing a kind of fine lattice work. Coarse lamellar striæ of growth become numerous towards the margin.

The test is comparatively thin, varying from 0·915 mm. to 1·28 mm. in thickness.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—At the first glance, particularly when compared with Messrs. d'Archiac and Haime's figure, it might appear that this species is identical with *Arca kurrachensis*, d'Arch. and Haime. I have, however, compared specimens from Sind with those from Burma and convinced myself that the latter represent a different species. *Arca kurrachensis* is of much larger size, more regularly rectangular in shape and much less twisted and the ribs are much coarser than those of *Parallelipipedum prototortuosum*; in fact the whole habitus of this species proves that it is closer related to *Parallelipipedum semitortum* than to *Parallelipipedum prototortuosum*. As already pointed out, the latter bears a close relationship to the living *Parallelipipedum tortuosum*, which is probably the direct descendant of the Miocene species.

3. Genus: CUCULLAEA, Lamarck.

CUCULLAEA PROTOCONCAMERATA, spec. nov., Pl. VIII, figs. 1, 1a, 2.

MEASUREMENTS.

	Length.	Height.	L/H.
Right valve .	29·8 mm.	29·8 mm.	1·00

The shell is trapezoid in shape, length and height being apparently equal; the index L/H is therefore very small, probably not much above 1; it is strongly inflated and inequilateral.

The umbo is tumid, incurvated and prosogyric, situated slightly in front of the middle line.

The pedal region is short, high, obliquely rounded; the siphonal region is short, high and truncated.

The anterior margin is long, oblique and convex, passing gradually into the rather short, slightly convex ventral margin; posterior margin long, oblique, forming a sharp angle with the ventral margin; cardinal margin long, straight, forming an obtuse angle with both anterior and posterior margins.

A sharp keel runs from the umbo towards the posterior corner; behind it the surface drops steeply and is slightly concave.

As far as can be seen, owing to the rather worn state of the shell, the surface was covered with numerous broad, flat, radiating ribs which are separated by deeply engraved linear interstices.

Hinge not well seen, but the horizontal teeth at its posterior and anterior extremity distinctly exposed.

Internal characters not observed.

Geological occurrence.—

Horizon unknown. Thayetmyo.

Remarks.—There can be no doubt as to the generic position of this species, because the horizontal teeth at either extremity prove that it is a typical *Cucullaea*. The specific characters could, however, not very satisfactorily be made out, because only two specimens have been found which are rather strongly weathered. The valuable characters of the surface ornamentation could therefore only partly be made out, by which the discussion of the relationship of this species will be influenced in some way.

It is, however, certain that it differs by its ornamentation from *Cucullaea granulosa*, Jonas; the remaining two species, *C. concamerata* and *C. auriculifera*, are by some authors considered as identical, a question which I do not want to decide. The identification of the fossil species is therefore somewhat difficult; from comparison with a specimen determined as *Cucullaea concamerata* from the Indian Ocean, I have, however, convinced myself that it is certainly the nearest relative to the fossil species; it seems to differ only by a larger size and a somewhat coarser ornamentation, a feature which is quite in harmony with similar observations made in other species. I therefore preferred to describe it under a new name.

Under the name of *Cucullaea auriculifera*, Martin describes a species from Java which, if not identical, appears to be closely related to the Burma species, but I question whether it is really identical with the living *Cucullaea auriculifera*. I rather feel inclined to think that the fossil species differs by a generally smaller shell and a more delicate ornamentation from the robust, living *Cucullaea auriculifera*, a feature which is obvious when Martin's figure, as well as that of the species here described are compared with Reeve's figure. I have, however, no doubt that the nealogic stage of *Cucullaea auriculifera* must have resembled so closely to the fossil species that it seems unquestionable that it has developed from that species. Its taller size and the somewhat coarser ornamentation would be quite in harmony with the similar tendency of evolution observed in other species.

If the view of the identity of *Cucullaea auriculifera* and *Cucullaea concamerata* should hold good, the species from Java and Burma would therefore be identical. This question can, however, only be settled by a comparative study of the two abovementioned recent species.

Family: *NUCULIDÆ*, Gray.

Genus: NUCULA, Lamarck.

The description of the species belonging to this genus, at least the fossil ones, suffers a great inconsistency, inasmuch as numerous palæontologists up to quite recently termed the posterior (siphonal) region of the shell the "anterior" one, and *vice versâ*.

Reeve in his monograph of the genus *Nucula* has already stated, "posterior side shorter, with apices turned towards the posterior side," and Wood in his monograph of the Eocene bivalves of England says on page 108, "in this genus it is often

difficult to determine in descriptions, which part is intended for the 'anterior' as that term is applied sometimes to the shorter, at others to the longer division of the shell. It is therefore quite obvious that that part of the shell which has been termed 'lunula' by those palæontologists, considering the shorter region the anterior one is not homologous to the lunula of other bivalves but to the escutcheon, and *vice versâ.*"

As the terminology of the shell is taken from the position of the animal, the terms "anterior" and "posterior" should be strictly applied to those parts of the shell towards which the pedal and siphonal side of the animal is turned.

I shall therefore term the shorter region the "posterior" one, and call with Fisher, Bernard and others the umbo "opisthogyric," *i.e.*, turned in posterior direction.

So far two species are known from the Miocene of Burma which can be distinguished in the following way:—

A. Umbo sub-central, escutcheon and lunula exhibiting transverse striæ; siphonal region tolerably long.
 1. *Nucula alcocki*, Noetling.

B. Umbo terminal, escutcheon and lunula not striated, siphonal region very short.
 2. *Nucula phayreiana*, spec. nov.

No living relative could be discovered of *Nucula phayreiana* which unquestionably represents a type extinct among the fauna of the Indian Ocean. On the other hand *Nucula alcocki* seems so closely related to the living *Nucula cummingii*, Reeve, that both species might be almost considered as identical.

NUCULA ALCOCKI, Noetling, Pl. VIII, figs. 3, *a-d*, 4, 4*a*, 5, 5*a*.

1895. *Nucula alcocki*, Noetling, Mar. Foss. from Mioc. of Upper Burma, Mem. Geolog. Survey of India, Vol. XXVII, pt. 1, p. 5, pl. I, figs. 5-7.

MEASUREMENTS.

	Length.	Height.	L/H.
Left valve	15·2 mm.	11·1 mm.	1·37

The shell is trigonal in shape, inequilateral, transversely elongate and considerably longer than high, but rather flat. The umbo is pointed, but low and depressed, opisthocline and situated in the posterior third of the length. Pedal region elongated, elliptically rounded, siphonal region short and attenuated. Anterior, ventral and posterior margin form a broad curve, which joins the posterior portion of the cardinal margin at a sharp angle, while the juncture of the anterior portion is rounded off. The cardinal margin is long, angularly broken, forming an angle slightly in excess of 90°; its anterior portion is slightly convex and nearly double the length of the posterior one, which is slightly concave.

There is no ornamentation, the whole surface being perfectly smooth; even concentric striæ of growth are hardly visible, but when slightly worn, a peculiar striated

sculpture appears, which is however due to the composition of the test. Below the smooth, extraneous and on the top of the inner nacreous layer, exists a layer which is composed of numerous fine radiating striæ, ribs so to speak, the interstices of which are filled with homogenous matter; each of these ribs corresponds to a crenulation of the margin. I formerly believed this to be a primary ornamentation, but I have since convinced myself that it is only of a secondary character due to the weathering of the surface layer.

The escutcheon is pretty large, slightly concave and well circumscribed by a rounded keel; there are a few fine transverse ribs which increase in size anteriorly on its central portion; these ribs or striæ are nothing else but the external marks of the posterior teeth. I have also convinced myself that they are not a secondary feature due to weathering, but that they are well marked on the external layer of well preserved specimens. The lunula is long, narrow and as well defined as the escutcheon; it is marked on either side with a line of short, transverse granules, increasing in size from the umbo in anterior direction, which are the external marks of the anterior teeth.

Ligamental groove rather large, triangular, obliquely turned forwards.

Teeth numerous, angularly broken, the internal, *i.e.*, the older ones, much smaller than the external, *i.e.*, the younger ones.

Muscular scars well marked, margin finely crenulated.

Geological occurrence.—

Zone of *Meiocardia metavulgaris*, Singu.
Zone of *Cancellaria martiniana*, Minbu.
Zone of *Paracyathus caeruleus*, Yenangyat.
Zone of *Arca theobaldi*, Kama.

Remarks.—Messrs. d' Archiac and Haime describe two species of *Nucula* from Western India, both of which seem, however, different from the species here mentioned. *Nucula* (?) *margaritana*, Lam. var., might perhaps be compared, but the figure of this species is too indefinite to allow for any certain conclusions to be drawn it seems, however, that the index L/H was much larger, and the shell therefore; less compressed in ventro-dorsal direction than *Nucula alcocki* is; the peculiar ornamentation of lunula and escutcheon appears also to be absent, so that the probability that both species are identical is very small.

The other species, *Nucula studeri*, d' Archiac and Haime, differs considerably by its shape.

From *Nucula phayreiana* it is easily distinguished by the peculiar sculpture of the lunula and the escutcheon, as well as by the more produced posterior portion of the valves by which the umbo is not terminal as in that species but more central.

Among the living species *Nucula cummingii*, Reeve, from the Indian Ocean appears to be the nearest relative, inasmuch as the posterior side of this species is similarly accuminated as in *Nucula alcocki* and the escutcheon was apparently in a similar manner marked as in that species.

NUCULA PHAYREIANA, spec. nov., Pl. VIII, figs. 6, *a-c*, 7, *a-d*.

MEASUREMENTS.

(*a*). Right valve

Length.	Height.	Thickness.	L/H.
10·0 mm.	8·6 mm.	2·7 mm.	1·16
9·1 „	8·2 „	?	1·09
7·8 „	6·4 „	?	1·21

(*b*). Left valve.

Length.	Height.	Thickness.	L/H.
8·8 mm.	7·3 mm.	?	1·20

The shell is obliquely trigonal, very inequilateral, a little longer than high and very flat; the small index L/H indicates the small difference between length and height sufficiently. The small pointed umbo is depressed but strongly opisthogyric, and situated nearly terminal, over the posterior part of the cardinal margin. The pedal region is elongate, slightly accuminate, the siphonal region extremely short and truncated. Anterior, ventral and posterior margin form a broad curve, which gradually passes into the straight, posterior portion of the cardinal margin, while it forms a pointed angle the corner of which is rounded off, with its anterior portion. The cardinal margin is angularly broken, both parts forming nearly an angle of 90°; the anterior portion is slightly curved and nearly double the length of the straight posterior one.

The surface is smooth, a few concentric striæ of growth become conspicuous towards the ventral margin, the radiating structure of the middle layer is well seen in specimens which are slightly weathered, the striæ are, however, much more closely set than in *Nucula alcocki*.

The lunula is long, narrow, but ill-defined by a shallow furrow on both valves, the escutcheon is broad, concave, and well marked by a rounded keel.

On the posterior portion of the cardinal margin there are only a few teeth, which apparently increase in size in anterior direction, on the anterior portion there are at least double the number of teeth, which quickly decrease in size towards the umbo.

The ligamental groove was apparently very small. The margin is very finely crenulated.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu,

Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—This species is easily distinguished from *Nucula alcocki* by the different shape of the shell, the valves having an extremely short pedal region and terminal umbones. The different character of lunula and escutcheon forms also a good distinguishing feature, while it is probable that it never attained the size of *Nucula alcocki*.

No living relative of this species could be traced and it unquestionably represents a type extinct among the fauna of the Indian Ocean, but owing to the indifferent characters of the shell no opinion can be given whether it has any relatives among the fauna of the European Eocene or not.

2. Genus: LEDA, Schumacher.

The genus *Leda* is represented by three species which can be easily distinguished in the following way :—

A. Shell large, surface smooth.
 1. *Leda birmanica*, spec. nov.

B. Shell small, surface concentrically ribbed.
 a. Shell triangular, ribs sharp, fine, closely set on the ventral, widely distant on the umbonal region.
  2. *Leda virgo*, K. Martin.
 b. Shell oblong, surface covered with flat broad ribs, separated by linear interstices running in oblique direction.
  3. *Leda avaënsis*, spec. nov.

None of these three species has a living relative among the fauna of the Indian Ocean and they represent therefore extinct types. One of them, *Leda virgo*, K. Martin, is identical with the species of the same name from Java, but no fossil or living relatives could be traced of *Leda avaënsis*, spec. nov.

Leda birmanica, spec. nov., Pl. VIII, fig. 12.

Measurements.

	Length.	Height.	L/H.
Right valve .	34·8 mm.	10·3 mm.	3·10

Only a single cast and the impression of the surface have come under examination, but they are sufficient to allow for an exact description.

The shell is transversely triangular in shape, the length exceeding the height considerably; the index L/H is therefore apparently rather high, it is very flat and rather inequilateral.

The umbo is very low, depressed, situated rather in front of the middle line.

The pedal region is short, broadly rounded, the siphonal region very elongate and broadly accuminated.

The anterior margin is rounded somewhat oblique, the posterior and ventral margin form a broad curve, which is strongly turned in dorsal direction at either end; anteriorly it passes gradually into the anterior margin, posteriorly it forms a sharp, acute angle with the cardinal margin. Cardinal margin very long, almost straight; the anterior portion is very short, the posterior nearly double the length of the former, slightly concave. As far as can be seen the ornamentation consisted only of coarse concentric striæ of growth. The hinge consists of numerous very small teeth.

Geological occurrence.—

Zone of *Meiocardia metavulgaris*, Singu.

Remarks.—Notwithstanding the rather ill-preserved state of the specimen, a few of the minute teeth composing the hinge could be well seen; this character

together with the general shape of the shell sufficed to determine the generic position with great accuracy.

From the other species here described it is easily distinguished by its large size, which, together with its shape, render any uncertainty as to the specific distinction almost impossible. No similar specimen has been described from either Java, Sumatra or Western India; neither can I find a living relative.

LEDA VIRGO, K. Martin, Pl. VIII, figs. 8, *a-d*, 9, *a-d*, 10, 10*a*.

1879-80. *Leda virgo*, K. Martin, Die Tertiärschichten auf Java, p. 113, pl. XIX, figs. 8, 8a.

MEASUREMENTS.

		Length.	Height.	L/H.
Complete specimen .	1.	9·1 mm.	4·9 mm.	1·86
" " .	2.	8·1 "	4·7 "	1·72

The small, flat shell is trigonal in shape, transversely elongate, the length always exceeding the height considerably, having as high an index L/H as 1·86. The shell is inequilateral, the pedal region being rounded, rather broad, the siphonal region strongly attenuated. The umbo is pointed, but very much depressed and turned backwards, situated nearly in the centre line. Anterior, ventral and posterior margin form a continuous broad curve; the cardinal margin is angularly broken, forming an angle of about 140°; its posterior part which is the longer one, joins the posterior margin at a very pointed angle, while anteriorly an obtuse angle is formed. There is no well defined lunula, but its place is marked by about 5 concentric striæ which are much stronger than those covering the whole surface.

The area is long, narrow, concave and also marked with a few concentric striæ bordered by a sharp keel, running from the umbo towards the junction of posterior and cardinal margin. The ornamentation consists of numerous very fine and regular concentric ribs, of uniform strength, which are separated by interstices of the same breadth, both terminating abruptly at the posterior keel. During the nealogic stage the ribs were wider distant than later on, and the contrast between the more distant ribs of the umbonal, and the closely set ribs of the ventral portion of the valves forms a most marked feature, which is equally observable in both valves.

There are about 15 angularly broken teeth in the anterior group, the interior, *viz.*, the oldest, being much smaller than the external ones; in the posterior group there are about 20 teeth of the same shape and arrangement, but generally somewhat larger than the anterior ones.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Remarks.—No similar species has hitherto been known from the Indian Tertiaries, but Martin has described under the name of *Leda virgo* a species from Java which is unquestionably the same as the species here described. Though being somewhat larger, the index L/H is apparently much the same, and though

Martin states that an area is absent it is well marked on his figure. As the ornamentation of both is the same, the chief difference would only be the widely distant ribs in the umbonal region of the Burma specimens, a feature which is not marked in those from Java, but which, everything else agreeing, may only be due to an oversight. Unless therefore future researches prove that there is really such a difference, the Burma and Java specimens must be considered identical. *Leda virgo* unquestionably represents a type which is extinct among the fauna of the Indian Ocean, but no relatives, either fossil or living, could so far be traced.

LEDA AVAËNSIS, spec. nov., Pl. X, fig. 11, *a-c*.

MEASUREMENTS.

	Length.	Height.	L/H.
Complete specimen	11·7 mm.	6·6 mm.	1·77

Only a single right valve of this specimen has come under examination, and even this is not well preserved, being so much worn that only traces of the ornamentation are visible. The small shell is inequilateral, oblong in shape and considerably longer than high, rather flat. The umbo is very low, depressed, pointed backwards and situated a little in front of the middle line. The pedal region is attenuated and considerably shorter than the rather long, expanded siphonal region. The anterior margin is short, and forms a broad curve with the ventral margin, which at its posterior end turns abruptly in dorsal direction and passes into the slightly curved posterior margin. Cardinal margin long, angularly broken, the longer posterior portion is slightly concave just behind the umbo, but afterwards runs parallel to the ventral margin and forms a right angle, the corner of which is rounded off, with the posterior margin; the shorter anterior portion is ventrally inclined and passes gradually into the anterior margin. An ill-defined keel runs from the umbo towards the posterior corner, and a similar one which is hardly visible at the junction of posterior and cardinal margin. The ornamentation consists of numerous, fine sharply engraved lines, with broader flat ribs between them. Though parallel among themselves, the lines run obliquely to the ventral margin and suddenly terminate in front of the first keel; the posterior portion is therefore smooth, except for some indistinct striæ of growth.

The hinge, though not well visible, consists of numerous small teeth.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.

*Remarks.—*The oblong shape, the broad posterior region together with the oblique lines readily distinguish this species from *Leda virgo*. The broad posterior portion renders it perhaps doubtful, whether this species belongs to the genus *Leda* or not; at least among the living species I find no similar one, exhibiting such a broad posterior side, though there are several which show the oblique concentric lines on the anterior portion of the shell.

Professor Martin describes under the name of *Leda subquadrata* a species

which as regards the outline has a great similarity to *Leda avaënsis;* the ornamentation of this species is, however, distinctly different as it consists of concentric lines parallel to the ventral margin while they are oblique to it in *Leda avaënsis*.

This species has no relative among the fauna of the Indian Ocean, and represents, therefore, an extinct type.

Family: *ASTARDIDÆ*, Gray.

Genus: CARDITA, Brugière.

The genus *Cardita* is represented by six species which can be easily distinguished as follows:—

A. Shell transversely elongate, index large.
  (*a*) Shell more or less rectangular.
    (*aa*) Whole surface covered with radiating scaly ribs, the posterior three of which are the strongest.
      1. *Cardita* (*Mytilicardia*) *scabrosa*, spec. nov.
    (*bb*) Only part of surface covered with radiating ribs, an area seemingly destitute of ribs on the posterior portion of the shell.
      2. *Cardita* (*Mytilicardia*) *protovariegata*, spec. nov.
  (*b*) Shell oval.
    (*aa*) Whole surface covered with radiating probably scaly ribs, one of which running from umbo to the posterior corner is the strongest.
      3. *Cardita* (*Mytilicardia*) *tjidamarensis*, K. Martin.

B. Shell triangular, index small.
  (*a*) 24 rounded, broad ribs with granulated ridge on their top.
      4. *Cardita* (*Venericardia*) *riquezneli*, d'Archiac and Haime.
  (*b*) 20 angular, broad flat and smooth ribs.
      5. *Cardita* (*Venericardia*) *planicostata*, spec. nov.
  (*c*) 16 roof-like, sharp ribs.
      6. *Cardita* (*Venericardia*), cf. *mutabilis*, d'Archiac and Haime.

One out of these six species only, *Cardita protovariegata*, has a direct descendant in *Cardita variegata* living in the Indian Ocean; the other five species represent extinct types, two of which, *Cardita scabrosa* and *Cardita tjidamarensis*, have very near relative in *Cardita crassicosta*, Lmk., and *Cardita pica* of the fauna of the Philippine Islands. No living relatives could be discovered of the remaining three species which probably have their nearest relatives in the Eocene, though it will be difficult to mention any names owing to the rather indifferent features of this radially ribbed Carditæ.

CARDITA SCABROSA, spec. nov., Pl. VIII, figs. 13, 13*a*.

MEASUREMENTS.

Length . . .	46·5 mm.
Height, anterior portion	25·5 „
„ posterior „	13·4 „
Thickness . . .	12·0 „

A nearly complete right valve and a fragmentary posterior portion of the left valve have come under examination.

The elongated shell is equivalve, but very unequilateral, the umbo obtuse and depressed, being nearly terminal. The pedal region is therefore contracted and short, the siphonal one, broadly expanded. The anterior margin is short and rounded; the ventral margin long and nearly straight, being slightly notched in the central part. The dorsal margin is long, apparently slightly curved, the posterior margin is broadly rounded, passing gradually into the dorsal and ventral margin.

Both valves are strongly gibbous in the anterior region, sloping gradually in posterior and strongly in ventral direction. The ornamentation consists of at least 12 (the exact number cannot quite be ascertained) radiating rounded ribs of a very peculiar appearance. Seven of these ribs are crowded on the pedal region of the valve, that is to say, they occupy the complete space in front of the ventral sinus. These ribs are, therefore, very closely set and thin, the anterior ones are strongly curved backwards, while the posterior ones are very slightly curved.

The remaining five ribs spread over the rest of the surface, extending from the umbo right to the margin. These ribs are very thick and nearly straight, the first two behind the sinus are not very prominent, but then follow two, exhibiting the greatest length and thickness, separated by a broad and flat interstice, the last one running close to the dorsal margin being a little thinner. These ribs are crossed by numerous coarse striæ of growth producing a scaly appearance. Some of the scales become very large, erect, resembling thorns, and bend over each other in posterior direction; although this feature is not well-marked in the complete valve, all the scales being broken off, the fragmentary specimen, however, still retains some of them. This fragment shows also that the three main ribs are nearly of the same strength.

Geological occurrence.—

Zone of ***Meiocardia metavulgaris***, Singu.

Remarks.—Messrs. d'Archiac and Haime have described under the name of *Cardita keyserlingi* a species which at the first moment appears to be identical with *Cardita scabrosa*, but on closer examination it will be seen that the species from Western India is much smaller and less inflated and that the ribs were apparently much more delicate. I cannot, however, refrain from drawing attention to the close relationship of the two species. During the adolescent stage *Cardita scabrosa* must have closely resembled to *Cardita keyserlingi*, particularly as the ventral sinus was not so conspicuous as in the later stage. The specimens figured by Messrs. d'Archiac and Haime are rather defective and it may perhaps be questioned whether figs. 15 and 16 actually represent one and the same species. I think it better not to go into this question for the present, and to postpone it until the Tertiary fossils of Western India have been re-examined.

Messrs. d'Archiac and Haime compare *Cardita keyserlingi* to *Cardita crassa*, Lmk., probably led to this assumption by a certain similarity in the ornamentation

with the species described as *Cardita crassa*, Lmk., by Deshayes.[1] If we compare, however, Deshayes' figure and that given by Reeve (Pl. VII, fig. 34) it is extremely difficult to understand how two species so widely different in shape and ornamentation could have been united under the same name. The reference of *Cardita keyserlingi* to the recent *Cardita crassa* is, therefore, quite an erroneous one, although I admit that it belongs to the same group as *Cardita crassa*, Deshayes.

There is, however, a particular feature which separates *Cardita scabrosa* from *Cardita keyserlingi;* in the former species the ribs are so closely set, that the interstices are very narrow all over the surface, while in the latter they are large and wide, at least on the posterior part of the shell. There is still another feature which in my opinion indicates the line of relationship, and this is the prominence of the posterior three or four ribs. I cannot find any fossil species in which this feature is so well marked as in *Cardita keyserlingi* and *Cardita scabrosa*, but there is a living species which exhibits this character in a fine way, and this is *Cardita crassicosta*, Lmk., from the Philippines. The general outline of both species, the fossil as well as the recent, is much the same, although *Cardita crassicosta* is much broader. The ornamentation is, however, in great harmony: the recent species bears eleven ribs, three of which are of larger dimensions than the remainder. The same feature is exhibited in *Cardita scabrosa*, the ribs showing exactly the same position as in the recent species, while the finer ones are distinctly restricted to the pedal region in front of the ventral sinus. The scaly appearance is of course much the same. The chief difference seems to be that the recent species is broader and bulkier than the Tertiary one, but the notion that the former has developed from the latter is difficult to suppress.

CARDITA (MYTILICARDIA) PROTOVARIEGATA, spec. nov, Pl. VIII, fig. 14, *a-c.*, Pl. IX, figs. 1, 1*a*, 2, 2*a*, 3, *a-c*, 4.

MEASUREMENTS.

	Length.	Height.	L/H.
1. Left valve	39 mm.	26·0 mm.	1·50
2. Right ,,	30·6 ,,	22·6 ,,	1·35
3. Compl. specimen	28·4 ,,	19·1 ,,	1·48

The shell does not vary much in shape which is generally rectangular; it is very inequilateral, the incurvated umbo being terminal and in a line with the anterior margin The pedal region is, therefore, very short and reduced, the siphonal one very long and broadly expanded. The anterior margin is short, rounded, forming a right angle with the straight ventral margin; the posterior margin is oblique, slightly curved, forming a pointed angle with the ventral margin and passing at an obtuse angle into the long, curved cardinal margin. In some specimens the cardinal margin is almost parallel to the ventral margin; in others which are

[1] Descr. des Coq. foss. des environs de Paris, Vol. I, p. 181 pl. XXX, figs. 17 and 18.

posteriorly more expanded, it runs obliquely to it, and is slightly convex. The valves are moderately inflated, the thickness of both valves being nearly the same as the height. The line of highest inflation runs from the umbo towards the posterior corner, dividing the surface in an uniformly inflated anterior, and as slightly inclined, sometimes a little concave posterior, region. The pedal region is covered with 14 strong, rounded radiating ribs, of which the anterior ten ones, separated by broad interstices are covered with low, coarse scales and gradually increase in strength, while the scales become more and more restricted to their ventral portion. Of the remaining four, the three first are the strongest, of about double the breadth of the anterior ones, apparently not provided with scales, while the last one is again thinner than the former. On the siphonal region two thin, somewhat scaly ribs run close to the hinge margin and appear to be separated by a broad apparently smooth band from the anterior ribs; if, however, carefully examined it will be seen that two hardly perceptible ribs occupy this space. The total number of ribs would therefore be not less than 18, which according to strength would follow each other in the following manner :—

10 *anterior*, scaly, thin ribs.
3 „ smooth, thick ribs.
1 „ smooth, thin rib.
2 *posterior*, hardly visible ribs.
2 „ scaly, thin ribs.

The lunula is small, but deep and well circumscribed by a sharp line.

The hinge is composed as follows :—

(*a*) *Right valve.*

1. Anterior lateral teeth : missing.
2. Cardinal teeth.

Close to the anterior margin there is a long lamellar tooth C3a which is almost parallel to the ventro-dorsal axis, perhaps slightly prosocline, having on its posterior (ventral) side a long triangular socket running almost parallel to it. The large triangular prosocline tooth C3p has a very broad basis: on its posterior (dorsal) side there is an elongate, narrow socket, followed by a long lamellar tooth C5p running nearly parallel to the posterior (dorsal) side of C3a, and so strongly prosocline, that it is almost horizontal, *i.e.*, parallel to the antero-posterior axis. The ligamental nymphe is so strong that it almost resembles another posterior tooth, and it might therefore easily be mistaken for C7p.

3. Posterior lateral teeth : missing.

(*b*) *Left valve.*

1. Anterior lateral teeth : missing.
2. Cardinal teeth.

Close to the margin is a narrow socket, running almost parallel to the ventro-dorsal axis, having on its posterior (ventral) side an elongate strong tooth C2*a*, which is just perceptibly prosocline; on the ventral side of C2*a* follows a large deep triangular socket, which has on its posterior side a long thin lamellar tooth

strongly prosocline and almost touching the apex of C2a; this tooth, C4p, has a deep, elongate and narrow socket on its dorsal side, followed by the strong ligamental nymphe which almost resembles another posterior cardinal.

The hinge formula is therefore as follows:—

Right valve La. O	C. 3a : 3p : 5p	Lp. O.
Left valve La. O	C. 2a : 4p :	Lp. O.

Anterior muscular scar small, but strongly marked; pallial impression rather distant from the obscurely crenulated margin.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.

Zone of *Cytherea erycina*, Prome.

Remarks.—The only fossil species to which *Cardita protovariegata* can be compared is *Cardita tjidamarensis*; the latter was, however, apparently more oval and quadrilateral in shape than *Cardita protovariegata*. The chief difference consists however in the weak, hardly perceptible development of the first two of the posterior ribs of the species under description, which convey the impression of a smooth posterior field. On the other hand in *Cardita tjidamarensis* the place of the two obsolete ribs is occupied by two very strong ribs, and in this species, therefore, the whole surface is uniformly covered with strong ribs.

Among the living species *Cardita variegata* at once marks itself as the nearest relative. General shape and ornamentation are so much the same, that one should feel inclined to consider the two species as identical; the chief difference consists, however, in the fact that in *Cardita variegata* all ribs are strongly developed, while in *Cardita protovariegata* two of the posterior ribs are hardly perceptible, the seemingly different ornamentation of the posterior field forms, therefore, a good distinguishing feature of both species. On the other hand, it is quite certain that *Cardita protovariegata* is the ancestor of *Cardita variegata*, the latter now living in the Indian Ocean and the Chinese Seas being its direct descendant.

Cardita (Mytilicardia) tjidamarensis, Martin, Pl. IX, figs. 5, *5a*.

1879-80. *Cardita tjidamarensis*, K. Martin, Die Tertiärschichten auf Java, p. 112, pl. XVIII, fig. 1.

The only specimen which has come under examination is a rather incomplete left valve; it is, however, sufficiently well preserved to allow for its determination. The exact dimensions cannot be given, but it measured certainly not less than 32 mm. in length and about 18 mm. in height. The shell is elongate, oblong, very inequilateral, the umbo being nearly terminal; anterior region short, posterior one elongate, but attenuated. Ventral margin apparently curved almost parallel to the straight dorsal margin, posterior margin oblique, joining the dorsal margin at an obtuse, the ventral margin at an acute, but rounded off angle. Moderately gibbous. Surface covered with straight radiating rounded ribs of which nine are still visible, but there were certainly not less than twelve. One rib, which runs

from the umbo to the junction of the ventral and posterior margin, is at the same time the strongest, and divides the surface of the shell in two parts exhibiting a different inclination; on the posterior part there are only three ribs, quickly decreasing in strength towards the dorsal margin, on the anterior part five ribs are visible, gradually decreasing in length and strength towards the anterior margin. Interstices of about the same strength as the ribs; both crossed by numerous, rather coarse striæ of growth which on the ribs apparently raise short nodules.

Geological occurrence.—

Zone of *Cardita tjidamarensis*, Singu.
Zone of *Meiocardia metavulgaris*, Singu.

Remarks.—It was only after some hesitation that I identified the rather fragmentary specimen here described with Martin's species. The general outline of the shell, the transversely elongated shape, the nearly terminal position of the umbo, but particularly the characters of the ornamentation have decided in favour of this view. There seems, however, to be some difference with regard to the number of ribs; Martin states that there are 16 ribs, and it appears from his figure that the ribs were apparently somewhat closer set than in the specimen under description. This question must remain undecided for the present, until more and better preserved specimens come to hand. In the meantime I wish to make a few remarks with regard to the relationship of this species. No species bearing any similarity to the above has hitherto been described from the Indian Tertiary formation, nor seems there to be any fossil relative in the European Tertiaries. Among the living species, *Cardita pica*, Reeve, from the Philippine Islands is apparently a very close relative; the general shape and ornamentation seem to agree very well with the fossil species; only that *Cardita pica* has apparently a larger number of ribs.

CARDITA (VENERICARDIA) VIQUESNELI, d'Archiac and Haime, Pl. IX, figs. 6, *a-f*, 7.

1853. *Cardita viquesneli*, d'Archiac and Haime, Descr. des anim. foss. du groupe numm. de l'Inde, p. 255, pl. XXI, figs. 7, 7*a*.

MEASUREMENTS.

(*a*) Right valve.	Length.	Height.	L/H.	(*b*) Left valve.	Length.	Height.	L/H.
1.	20·7 mm.	15·4 mm.	1·34	1.	14·7 mm.	11·3 mm.	1·30
2.	18·3 „	14·1 „	1·30				

The shell is triangularly oval in shape, the length being somewhat in excess of the height, and the index L/H is therefore small; it is rather inequilateral and moderately flat.

The umbo is pointed but somewhat depressed, prosogyric and situated well in front of the middle line.

The pedal region is short, rounded; the siphonal one considerably longer, attenuated and obliquely truncated.

The anterior margin is broadly rounded, passing gradually into the almost straight, slightly convex, ventral margin, which in its turn forms a pointed angle, the corner of which is slightly rounded off with the straight and oblique posterior margin. The cardinal margin is rather long, slightly curved and inequilateral; the shorter anterior portion passes gradually into the anterior margin, while the longer posterior portion forms a very obtuse angle with the posterior margin.

The surface is covered with 24 radiating ribs of uniform strength, apparently separated by interstices of more than double their own breadth; on closer examination it will, however, be seen that each rib is rather broad, rounded and bears on the top a fine angular granulated ridge; the granules are generally better developed on the anterior than on the posterior ribs, where the top ridge also becomes more or less indistinct.

The lunula is very small, but deeply sunk and sharply defined.

The hinge is composed as follows:—

(*a*) *Right valve.*

1. Anterior lateral teeth.

Close to the anterior margin there is a small circular socket, having on its ventral side a very rudimentary granular prominence, LaI.

2. Cardinal teeth.

Almost amalgamated to the anterior margin is a strong, but short strongly opisthocline tooth C3a. On its posterior (ventral) side is a deep elongate socket and behind it the large triangular tooth C3p, having its apex right underneath the umbo; its anterior side being posteriorly, its posterior side anteriorly inclined.

Parallel to its posterior side runs a narrow elongate socket, having on ist posterior side, amalgamated to the ligamental nymphe an elongate tooth C5p.

3. Posterior lateral teeth: missing.

(*b*) *Left valve.*

1. Anterior lateral teeth.

Close to the anterior margin there is a rudimentary granular tooth, the axis of which runs almost parallel to the antero-posterior axis representing La II.

2. Cardinal teeth.

There is a short, strongly opisthocline tooth, C2a, having a deep socket on its anterior dorsal side, and separated by a triangular socket, from an elongate lamellar, strongly prosocline tooth C4p, which touches the apex of C2a; on the dorsal side of C4p is a very elongate socket running, parallel to it, and then follows the ligamental nymphe.

3. Posterior lateral teeth; missing.

The hinge formula is therefore—

Right valve La. : I	C. 3a : 3p : (5p)	Lp. O.
Left valve La. II	C. 2a : 4p :	Lp. O.

Muscular impressions rather large but not well marked, margin deeply crenulated.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Meiocardia metavulgaris*, Singu.
Zone of *Parallelipipedum prototortuosum*, Kama.
Zone of *Aricia humerosa*, Thayetmyo.

Remarks.—In general shape this species greatly resembles *Cardita planicostata*, but it is easily distinguished from that species by the different ornamentation of the surface, which although it consists of radiating ribs in both species differs materially as to detail; in the species under description the ribs are rounded having a granulated ridge on the top, while they are flat and angular in *Cardita planicostata*.

Two among the species from Western India, *Cardita mutabilis* and *Cardita viquesneli*, have to be considered when compared with the species under examination. The former exhibits the triangular shape of the specimens from Burma, but to judge from the ornamentation both species are different; *Cardita mutabilis* exhibits a smaller number of ribs, which are composed of granules, while on the Burma specimens the granules form a line on the top of a smooth rounded rib. The second species, *Cardita viquesneli*, appears to have a perfectly different shape, and on comparison of Messrs. d'Archiac and Haime's figure with the figure given here the difference is at once obvious, inasmuch as *Cardita viquesneli* as depicted by Messrs. d'Archiac and Haime has a more circular shell, while that of the Burma specimens is distinctly triangular. On the other hand, the ornamentation is exactly the same: both species have 24 ribs, and each rib being rounded and bearing a granulated keel on its top; according to fig. 7 the complex nature of the ribs is only developed at the adult stage, while during the nealogic stage, the ribs were simple. The same feature is well represented in the specimens from Burma, and I have, therefore, notwithstanding the difference in the outline of the shell, identified the specimens from Burma with *Cardita viquesneli*, believing that Messrs. d'Archiac and Haime's figure does not give the correct outline, a view which is the more probable, as only a single left cast served for description.

Bœttger described under the name of *Cardita globiformis*[1] a species from Sumatra, which seems to have a great likeness to *Cardita viquesneli;* in some of my specimens the interstices are filled up with matrix, only the granulated ridge being exposed; in this case the nature of the ribs is concealed, and one might be led to believe that they are simply granulated; the specimens are then so very much like those of Bœttger that I cannot suppress some doubts as to the actual ornamentation of Bœttger's specimen; if my doubts were founded Bœttger's species has to be cancelled; I am, however, unable to say anything definite without a reference to Bœttger's type of *Cardita globiformis*. No living relative of this species could be discovered and it unquestionably represents a type which is extinct among the fauna of the Indian Ocean.

[1] Tertiärformation von Sumatra, page 38, Pl. 1, figs. 21—23.

CARDITA PLANICOSTATA, spec. nov., Pl. X, figs. 1, 1a.

No exact measurements could be taken as none of the specimens, though they are rather frequent, was well preserved. It seems, however, certain that the shell did not attain a large size, and that the length only slightly exceeded the height; the index L/H must, therefore, have been rather small.

The shell is triangular in shape, rather flat and moderately inequilateral.

The umbo is small, pointed, slightly prosogyric, and situated in front of the middle line.

The pedal region is short, rounded, the siphonal region a little longer, accuminated and truncated.

The anterior margin is broadly rounded, passing gradually into the slightly convex ventral margin, which forms a sharp angle with the short oblique posterior margin; cardinal margin angularly broken, both portions strongly inclined in ventral direction, the posterior one being the longer.

An obtuse rounded keel runs from the umbo towards the posterior corner, and behind it the surface slopes steeply.

The lunula is small, deeply concave and well circumscribed.

The ornamentation consists of about 20 flat radiating ribs, separated by interstices of about the same breadth; the ribs have an angular section, their sides being perpendicular, the top flat, even slightly excavated.

Margins deeply crenulated, the ribs of one valve interlocking with the interstices of the other.

Characters of the hinge and internal characters not observed.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Pholas orientalis*, Thayetmyo.
Zone of *Aricia humerosa*, Thayetmyo.

Remarks.—The only species to which *Cardita planicostata* could be compared is *Cardita viquesneli*, d'Arch., but both species are easily distinguished by the character of the ornamentation. In the species under examination the ribs are broad, flat, angular, while those of the other species are fine, filiform ribs on the top of a rounded base. No similar species has been described either from Java, Sumatra or Western India; neither can I find any living species to which I could compare *Cardita planicostata*; in fact it appears as if this group of *Carditæ* characterized by a triangular flat shell, with flat, angular, rather widely apart, radiating ribs, seems to represent an antiquarian element having its nearest relatives in the Eocene formation.

CARDITA CF. MUTABILIS, d'Archiac and Haime, Pl. X, fig. 2.

1853. *Cardita mutabilis*, d'Archiac and Haime, Descr. des Anim. foss. du groupe numm. de l'Inde, p. 266, pl. XXI, figs. a, 3a, 4a, 5a, 6a, b.

There is only a single cast of a species which seems to belong to the one above referred to which has come under examination. It is a right valve, measuring

13·3 mm. in length and 10·3 mm. in height; the valve is moderately inflated, inequilateral, triangular in shape; the umbo is obtuse, tumid, somewhat in front of the centre; the pedal region is short, somewhat contracted, the siphonal one broad. Anterior and ventral margin curved, posterior one straight, joining the ventral margin at a rounded off angle. Surface covered with not less than 16 angular (?) radiating ribs, separated by interstices of the same breadth. Ventral margin denticulated.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.

Zone of *Meiocardia metavulgaris*, Singu.

Remarks.—The incomplete state of the only specimen under examination prevents any more definite description, but it is apparent that it bears the closest relationship to *Cardita mutabilis*, d'Archiac and Haime.

Family: *CRASSATELLIDÆ*, Gray.

Genus: CRASSATELLA, Lamarck.

Two species which apparently represent two different sections of this genus have been described here, which may be easily distinguished as follows:—

A. Shell elongate, strongly rostrated at the posterior end; umbonal region covered with fine concentric wrinkles or ribs, other part of surface smooth.

1. *Crassatella dieneri*, spec. nov.

B. Shell rhomboidal, posteriorly truncated, surface smooth.

2. *Crassatella rostrata*, Lamarck.

The last named species is unquestionably identical with *Crassatella rostrata*, Lam., living in the Indian Ocean, while *Crassatella dieneri*, spec. nov., represents an extinct type, which has, however, its nearest relative in the living *Crassatella jubar*, Reeve, from the Philippine Islands.

Crassatella dieneri, spec. nov., Pl. X, fig. 8, *a-d*.

Measurements.

	Length.	Height.	L/H.
1.	37·0 mm.	21·4 mm.	1·73
2.	36·4 „	21·7 „	1·67

Only right valves of this species have come under examination, but they are so well preserved that the specific characters can be fixed with accuracy.

The shell is elongately triangular in shape, much longer than high; the index is therefore rather high; it is very inequilateral and strongly inflated.

The umbo is moderately inflated, but strongly curved inwards, prosogyric, situated slightly in front of the middle line.

The pedal region is short, accuminated, the siphonal region very elongated and produced into a long beak.

Anterior and ventral margin form a broadly convex line, which is slightly sinuated at the posterior end. Posterior margin very short, rounded, forming an obtuse angle, the corner of which is rounded off, with the ventral margin and passing gradually into the cardinal margin. Cardinal margin rather long, angularly broken, inequilateral. The shorter anterior part is strongly inclined in ventral direction forming a rounded off angle with the anterior margin; the longer posterior portion is slightly inclined in ventral direction and passes gradually into the posterior margin.

A strong rounded keel runs from the umbo towards the posterior corner, setting off a narrow posterior area which drops nearly perpendicularly at its umbonal, and very gently at its ventral part. Another sharp line, behind which the surface is slightly concave, runs from the umbo towards the cardinal margin.

There is a large and very deep, sharply circumscribed lunula.

During the nealogic stage the surface in front of the keel was covered with sharp concentric ribs separated by broad concave interstices; the posterior field exhibited only fine concentric striæ of growth; after the shell had exceeded the height of 3·4 mm. the ribs become effaced and the whole surface is only covered with numerous fine, but somewhat irregular striæ of growth.

Only the hinge of the right valve is known, and even this only in rather an imperfect state; there is a long and thin lamellar tooth C1 which is slightly thicker and bifid at its ventral end. In front of it is a deep triangular socket, obviously corresponding to C2a and behind it a broad and deep triangular socket. In front of the anterior socket there is a deep, horizontal groove, bordered on its ventral side by a thin elongated lamella; it is very possible that both correspond to LaI and LaII respectively.

Pallial impression strongly marked, apparently not sinuated.

Ventral margin very finely crenulated.

A strong broad ridge which is slightly posteriorly inclined runs on the inside from the umbo towards the ventral margin.

Test thick, measuring 3·4 mm. at the umbonal region, but increasing rapidly in ventral direction.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.

Zone of *Meiocardia metavulgaris*, Singu.

Remarks.—The only species to which *Crassatella dieneri* could be compared is *Crassatella rostrata;* it is, however, distinguished from this species by its more elongate shape, and therefore by a higher index L/H, by its flatter only slightly curved ventral margin, more inflated surface and stronger posterior keel.

Crassatella dieneri is a typical example of a small group, which is well characterised by its rostrated siphonal region. Among the living species *Crassatella jubar* from Western Australia seems to be the nearest relative; as I have, however, no specimen for comparison I am only able to judge from Reeve's figure.

Crassatella jubar appears to have had a larger and generally more stouter shell, but if I interpret Reeve's description correctly, it exhibited similar concentric ribs on the umbonal region as *Crassatella dieneri.*

Crassatella rostrata, Lam., spec. nov., Pl. X, figs. 4, 5.

Crassatella rostrata, Reeve, Monograph of the Genus *Crassatella*, pl. II, fig. 10.

Measurements.

	Length.		Height.		L/H.
1.	35·2 mm.	.	24·6 mm.	.	1·43
2.	27·0 ,,	.	18·7 ,,	.	1·44

The shell is equivalve, transversely rhomboidal in shape, the length being somewhat in excess of the height; it is moderately inflated, not very inequilateral.

The umbo is low, and situated in front of the middle line.

The pedal region is short, accuminated, the siphonal region slightly longer, accuminated. The anterior and ventral margin form a broad strongly convex curve; it might be almost said that the antero-ventral margin is angularly broken in the middle; the posterior margin is very short, oblique, forming an obtuse angle with the ventral margin. The cardinal margin is long, angularly broken, the posterior longer portion forms a very obtuse angle with the posterior margin, while the shorter anterior portion forms a pointed angle with the anterior margin.

A broad rounded, rather flat keel runs from the umbo towards the posterior corner, separating a narrow steeply inclined posterior area from the anterior portion of the surface.

Lunula long, deeply concave, but narrow.

As far as can be judged, the ornamentation consisted in the full-grown shell only of numerous, fine, somewhat irregular striæ of growth, but during the nealogic stage, as represented by the umbonal region, the anterior part of the surface was covered with angular concentric ribs, separated by broad concave interstices.

The upper (?) layer of the shell exhibits a peculiar radiated structure which results in a finely crenulated antero-ventral margin.

Muscular scars, particularly the anterior one, very deeply sunk; pallial impression apparently entire or perhaps very slightly sinuated. Characters of the hinge not observed.

Test thick, measuring about 4 mm. in thickness at the umbonal region. This species has a very thick nacreous layer, while the upper, or, as is much more probable, middle radiated layer was rather thin.

Geological occurrence.—

Zone of *Aricia humerosa*, Thayetmyo.

Remarks.—The less elongated, higher rhomboidal shape of the shell, which is much less rostrated in posterior direction, readily distinguishes this species from *Crassatella dieneri.*

The nearest living relative is *Crassatella rostrata* from Ceylon; in fact the

similarity between the two species is so large that I have no hesitation in identifying both.

Family: *LUCINIDÆ*, Deshayes.

Genus, LUCINA, Brugière.

This genus is represented by three species which probably represent so many sections of sub-genera, can be easily distinguished as follows:—

A. Shell covered with radiating, wrinkled ribs.
   1. *Lucina neasquamosa*, spec. nov.

B. Shell covered with concentric, sharp ribs.
   2. *Lucina pagana*, spec. nov.

C. Shell smooth.
   3. *Lucina d'archiaciana*, spec. nov.

These three species represent types which are undoubtedly extinct among the present fauna of the Indian Ocean, but two of them, *Lucina neasquamosa* and *Lucina pagana*, have their nearest living relatives in *Lucina venusta*, Reeve, and *Lucina philippinarum*, Reeve, from the Philippine Islands. At the same time these two species have so near relatives in *Lucina squamosa*, Lmk., and *Lucina squamula*, Des., from the Eocene of Paris that the notion that they represent their direct descendants is difficult to suppress. No living relative could be traced of *Lucina d'archiaciana*, spec. nov., though it is very probable that the nearest relative of this species lived in the Eocene of Paris.

LUCINA NEASQUAMOSA, spec. nov., Pl. X, fig. 6, *a-d*.

MEASUREMENTS.

(*a*) Right valve.

	Length.	Height.	Thickness.	L/H.
1.	10·4 mm.	16·8 mm.	6·0 mm.	1·15
2	11·5 "	10·4 "	3·6 "	1·10

(*b*) Left valve.

Length.	Height.	Thickness.	L/H.
9·2 mm.	8·2 mm.	3·0 mm.	1·12

The shell is of small size only, almost orbicular in shape, length and height being nearly the same, sub-equilateral. As only three specimens have come under examination, nothing can be said about the variation of the index L/H. The umbo is pointed, small, prosogyric, situated nearly medially. The pedal region is broad, round, the siphonal region broad, truncated and slightly sinuated by a shallow depression, which runs from the umbo towards the posterior margin. Anterior, ventral and posterior margin form nearly a complete circle, which joins the nearly straight cardinal margin at an obtuse angle at either side.

The shell is only slightly inflated, a little concave on the siphonal region.

The lunula is comparatively large, concave, but not sharply circumscribed, exhibiting a few obscure radiating ribs.

The ornamentation consists, generally speaking, of numerous fine radiating

ribs crossed by strong concentric lines; the radiating ribs, certainly not less than 50 in number, are rounded, very closely set and separated by engraved linear interstices. The arrangement of the ribs is as follows: there are six or seven anterior ribs which are of about double the thickness as the others, decreasing, however, in posterior direction; immediately behind these follow about 40 fine filiform ribs, gradually increasing in strength in posterior direction, without ever reaching the thickness of the anterior ribs. Then follows a smooth space and near the cardinal margin again three indistinct ribs. Besides, sometimes strong striæ of growth, the ribs are crossed by numerous very closely set, strong concentric lines which passing uniformly across ribs and interstices, produce a sort of scaly undulating wrinkles.

In the right valve there are two minute teeth below the umbo, the ventral one of which is the larger; they are separated by a small triangular socket, while there is another in dorsal direction of the larger tooth: if these teeth are considered as C3a and C3p, those in the left valve must represent C2a and C2p. A small rudimentary anterior lateral, representing LaI and II is seen in either valve, while it is almost certain that in neither valve there are posterior laterals, or if present they are so rudimentary as to be hardly visible. The hinge formula would therefore be:—

Right valve La.: I	C. 3a : 3p :	Lp. O.
Left valve La.: II	C.: 2a : 4p	Lp. O.

The anterior muscular scar is ribbon-like, large, obscurely defined, the posterior one large, rounded; pallial impression entire, well marked. Margin finely crenulated.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—This species has an exceedingly *Cardium*-like appearance which is increased by its rudimentary hinge, and if the impression of the anterior muscular scar were not known, it might be easily mistaken for a species of this genus. As it is its generic position is unquestionable, and it is easily distinguished from the other species by its radiate, wrinkled ribs of which the anterior ones are much stronger than the remainder.

No similar species has been described either from Western India or Java and Sumatra, but there is a living species, *Lucina venusta*, Reeve, from the Philippine Islands which apparently bears a close relationship to this species; unfortunately I have no material of this species for comparison and I am therefore obliged to draw my conclusions from Reeve's figure, which leaves much to be desired. The general ornamentation of both species is much the same though *Lucina venusta* seems to have acquired a larger size; there are even the thicker, anterior ribs distinctly noticeable in Reeve's figure, though they seem to be less numerous and restricted to the lunula only, while in *Lucina neasquamosa* they occur behind the lunula.

Taking everything into consideration, I believe that *Lucina venusta* is a descendant of *Lucina neasquamosa*, but that this type has died out among the fauna

of the Indian Ocean. On the other hand, *Lucina neasquamosa* appears to be so similar to *Lucina' squamosa*, Lmk., from the Paris Eocene that it appears almost difficult to find any difference; it is, therefore, almost certain that *Lucina neasquamosa* is the descendant of the Eocene *Lucina squamosa*, while the descendant of *Lucina neasquamosa* exists at present in the shape of *Lucina venusta* in the Eastern Seas.

LUCINA PAGANA, spec. nov., Pl. X, figs. 7, *a-b*, 8, *a-b*.

1895. *Venus cf. scalaris*, Noetling, Marine Foss. from Miocene Upper Burma, Mem. Geolog. Survey of India, Vol. XXVII, p. 12, pl. III, fig. 4.

MEASUREMENTS.

	Length.	Height.	Thickness.	L/H.
Right valve .	9·4 mm. .	9·0 mm. .	2·2 mm. .	1·06
Left "	. 12·2 "	. 12·1 "	. 3·2 "	. 1·00

The small shell is sub-trigonal in shape, length and height being nearly the same; the index L/H is, therefore, very small; the valves are very flat and sub-equilateral. The umbo is small, pointed and strongly prosogyric situated in the anterior third of the length. Pedal region short, attenuated, siphonal region broad, obliquely truncated. Anterior and ventral margin form a broad circle, the former meeting the cardinal margin at an obtuse angle; posterior margin short, oblique and strongly sinuated, forming a sharp angle with ventral and cardinal margin. Cardinal margin long, strongly curved. A broad and deep depression which runs from the umbo to the posterior margin broadly sinuates the latter and is bordered in front by a sharp keel.

The ornamentation consists of fine, lamellous concentric ribs, which are separated by broad, flat interstices exhibiting only a few striæ of growth. Apparently the distance between the ribs varies greatly; in two specimens they are very broad, and the number of ribs is consequently small, in another specimen the ribs are very numerous and closely set; the interstices are, therefore, very narrow.

Lunula ill-defined, slightly concave.

In the right valve there are two pretty strong anterior laterals, separated by a deep socket, and one posterior lateral accompanied on either side by a socket; the ventral socket is short, the dorsal one narrow; these teeth represent therefore LaI and III and LpIII respectively, while the sockets correspond to LaII and LpII and IV in the left valve; there is a very short anterior and an elongated posterior cardinal tooth separated by a short socket; these teeth represent C3a and C3p, respectively, while the socket in front of C3p as well as that behind it correspond to C2a and C4p. The hinge formula of *Lucina pagana* reads therefore as follows:—

Right valve La. I : III	C. 3a : 3p :	Lp. : III :
Left valve La. II	C. : 2a : 4p	Lp. II : IV.

This formula differs from the general formula for the genus by having on Lp III in the right valve instead of Lp I and III, while in the left valve there

are LpII and IV instead of only LpII. As, however, the hinge of *Lucina* is very variable too much importance should not be attached to this feature.

The anterior muscular scar right underneath LaI is deeply sunk and rather long; posterior one small; pallial impression entire, strongly marked, rather distant from the sharp bevelled margin.

Geological occurrence.—

Zone of *Paracyathus caeruleus*, Yenangyat.

Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—No similar species has hitherto been described from India or Java or Sumatra. K. Martin mentions quite a number of species from Java, but the Burma species differs by its shape, ornamentation and particularly by the posterior depression from all of them.

Among the living species *Lucina philippinarum*, Reeve, seems to be the nearest relative, although this species is edentulous and of much larger size. It is, however, well known that Lucines when reaching the ephebolic or geratologic stage become edentulous, so that too great importance should not be attached to this fact.

With regard to the larger size of *Lucina philippinarum* its nealogic stage should be considered when compared with *Lucina pagana;* a young specimen of the former must have exactly resembled the latter; in fact, the radiating raised striæ which form such a conspicuous feature of the adult *Lucina philippinarum* were not developed in the nealogic stage and have only been acquired during a later period.

It is therefore quite possible that *Lucina pagana* is the ancestor, from which *Lucina philippinarum*, which at present occurs from Singapore to the Philippine Islands, has descended, but appears to have died out among the fauna of the Indian Ocean. It is very probable that the ancestor of *Lucina pagana* occurs in the Eocene of Paris, because *Lucina squamula*, Desh., seems a very close relative.

LUCINA D'ARCHIACIANA, spec. nov., Pl. X, fig. 9, *a-c*.

MEASUREMENTS.

Length.	Height.	L/H.
19·3 mm.	17·3 mm.	1·11

The shell is rather small, nearly orbicular in shape, the length only slightly exceeding the height; the index L/H is therefore rather small; it is strongly inflated and rather inequilateral.

The umbo is inflated, strongly prosogyric and situated in front of the middle line.

The pedal region is short, a little acuminate, the siphonal region is slightly longer, broadly expanded and truncated.

The anterior margin is short, rounded and forms with the convex ventral margin a broad curve; the posterior margin is moderately long, almost straight

or only slightly convex, forming a very oblique angle with both ventral and cardinal margin; the cardinal margin is rather long, angularly broken; the anterior part is slightly concave and strongly inclined in ventral direction, the posterior part is almost straight or at least only slightly convex, running parallel to the antero-posterior axis.

The lunula is slightly concave, ill-defined.

An obtuse keel runs from the umbo towards the junction of ventral and posterior margin; behind it the surface is steeply inclined and slightly concave.

The ornamentation consists of numerous sometimes strong, sometimes finer concentric striæ of growth.

Internal characters not observed.

Geological occurrence.—

Zone of *Dione dubiosa*, Yenangyat.

Remarks.—The characters of the hinge, as well as those of the pallial impression and muscular scar being unknown, the generic position of the species may perhaps be challenged, and it was chiefly the general shape which has guided me in including it among the genus *Lucina*, a view which, however, requires further confirmation.

From the two other species it is easily distinguished by its generally larger size, and the smoothness of the surface, there being, except striæ of growth, no other sort of ornamentation.

No living relative of this species could be found among the fauna of the Indian Ocean, and it must be considered as representing an extinct type. I refrain from comparing it to other species, because its generic position is not beyond any doubt, as long as the characters of the hinge are not known; but there are certain species among the Eocene fauna of Paris like *Lucina concava*, Def., which appear to be very similar to *Lucina d'archiaciana*.

Family: *CARDIIDÆ*, Lamarck.

Genus: CARDIUM, Linné.

Only two species of the genus have come under examination, which can be easily distinguished as follows:—

A. Shell oval, index small, covered with barbed ribs.
   1. *Cardium protosubrugosum*, spec. nov.
B. Shell rhomboid, index large, covered with rounded ribs.
   2. *Cardium minbuense*, spec. nov.

No living relative could be traced of *Cardium minbuense*, spec. nov., which represents an extinct type, but *Cardium protosubrugosum*, spec. nov., is unquestionably closely related to the living *Cardium subrugosum*, though it seems as if this which had developed certain features with regard to the character of the hinge species were not present in the fossil specimens.

Cardium protosubrugosum, spec. nov., Pl. X, figs. 10, *a-c*, 11.

Measurements.

	Length.	Height.	L/H.
1.	17·6 mm.	. 23·0 mm.	. 0·76
2.	17·4 „	. 22·1 „	. 0·78

There are only two, though well preserved left valves which have come under examination, but they allow a perfect description of the species. The shell is rather inequilateral, oval and considerably higher than long; the index L/H is therefore smaller than 1, though of course nothing can be said as to its variation. It is strongly and uniformly inflated, being anteriorly steeply inclined, while it drops moderately in posterior direction. The umbo is highly tumid, strongly prosogyric and situated slightly in front of the middle line. The pedal region is short, rounded, the siphonal one a little longer, and rounded. Anterior, ventral and posterior margin form an ellipse, the long axis of which coincides with the ventro-dorsal axis. The cardinal margin is short, curved and passes gradually in both posterior and anterior margins.

The lunula is moderately large, slightly concave, and well circumscribed, destitute of any sculpture, except concentric striæ of growth.

The ornamentation consists of 32 simple, radiating ribs, separated by angular interstices of the same breadth. The ribs have a roof-like section, and exhibit quite a peculiar muricated sculpture. The section of the ribs changes considerably in antero-posterior direction; the anterior ribs are flat, nearly circular in section, but they gradually become higher and their section more angular; with regard to the ornamentation three groups of ribs may be distinguished; the anterior ones are strongly muricated; on the central ones the flanks are set with sharp oblique striæ; when the top of the ribs is slightly worn off they present a curious barbed appearance; in the third group, the posterior six or seven ribs, the sculpture is again modified in the following way: on the posterior flank of each rib a fine furrow appears which divides a smooth anterior branch from a posterior one, set with distant short granules. Towards the margin the posterior branch of each rib joins the anterior one of the succeeding rib.

Both valves are strongly interlocked, the margin is therefore deeply crenulated, particularly in posterior direction.

In the left valve there is a strong, slightly oblique, elongated lateral, having a deep groove on its dorsal side; this lateral is certainly LaII, while the socket should correspond to LaIII in the right valve. The cardinals below the umbo are small, thorn-like, the ventral one being the bigger; they represent C2a and C2p; there is a minute posterior lateral socket corresponding to Lp in the right valve. The hinge formula would, therefore, be as follows:—

Right valve La. III : I ?	C. 3a : 1 :	Lp. I.
Left valve La. : II	C. : 2a : 2p.	Lp. :

With regard to the right valve the above formula is a little conjectural. I do not know for instance whether there exists LaI, and of what strength; it is possible that it may not have existed at all or was very rudimentary, but it is certain that LaIII was rather strong. With regard to the posterior lateral, the socket in the left valve will most probably correspond to LpI, but no trace of LpII is visible, and if present it must have been very rudimentary.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.

Zone of *Aricia humerosa*, Thayetmyo.

Remarks.—The shape, as well as the peculiar ornamentation readily distinguish this species from all the others.

No similar specimen has been described from either Western India or from Java or Sumatra, but the living *Cardium subrugosum*, Sowerby, which inhabits the Indian Ocean, and ranges as far East as the Philippine Islands, is certainly identical with this species, although it is certain that all the features of the living *Cardium subrugosum* are developed in a more coarse, stronger way.

A right valve of *Cardium subrugosum*, which I have under examination, measures 37·2 mm. in length and 45·6 mm. in height; the index is therefore 0·81, that is to say, very nearly that of the fossil species. The general shape of the living one is exactly that of the fossil species, although it attains a much larger size; the number of radiating ribs, 31, is as near as possible that of the fossil species, but what is more important, the ribs exhibit the same ornamentation, particularly with regard to the barbed appearance of the central ribs; the three groups are well discernible: we have first the flat, rounded, muricated ribs, then follow those of an angular roof-like section, their flanks being set with sharp striæ, and in order that the similarity be as near as possible, their top is slightly worn, and the barbed feature therefore much in appearance. The posterior group shows the same ribs set with distant thorns, but it may be remarked that the thorns are closer as well as the anterior smooth branch much less developed. This constitutes in fact the only difference with regard to the ornamentation.

Strange to say, there is a considerable difference with regard to the constitution of the hinge, but I am not quite sure whether this should not be regarded as an evolutionary feature. In the right valve there is a strong thorn-like anterior lateral LaI, having on its dorsal side a deep socket for LaII, on the dorsal side of which there is a granule representing a rudimentary LaIII. The cardinal teeth are thorn-like, C1 being very strong, C3 weak and obsolete; there is a strong posterior lateral LpIII, and on its dorsal side a deep groove for LpII. The hinge formula would, therefore, be as follows:—

Right valve La. (III) : I	C. 3a : 1 :	Lp. I :
Left valve La. II :	C. : 2a : 2p	Lp. II.

If we compare this formula with that of the fossil species we see that in the living species LaI is very strong and LaIII rudimentary, while it is quite certain that in the fossil species LaIII was very strong, and nothing is known about LaI;

which may have been rudimentary or strong, but the difference with regard to LaIII is unquestionable; with regard to the cardinals nothing can be said, but with regard to the posterior laterals it is certain in the left valve of the living species a strong LpII existed, while if it existed in the fossil species it was exceedingly rudimentary; LpI existed in both species, but it is very strong in the living, while nearly obsolete in the fossil specimen.

The deviations concern therefore chiefly the laterals, and I am not sure whether, as already said, this should not be considered as an evolutionary feature, the tendency being chiefly directed towards the strong development of the posterior laterals, while from the anterior laterals LaI developed at the expense of LaIII.

The question now arises, do such differences create a specific difference or not? I think that if we remember the tendency expressed in the evolution of the Miocene fossils, a tendency directed towards the creation of larger specimens and coarser sculpture, it will be advisable to distinguish this species under a separate name, but the living *Cardium subrugosum* is unquestionable the direct descendant of the Miocene *Cardium protosubrugosum*, having, however, during the time of evolution developed some particular features in the hinge which had not been indicated in its fossil ancestor.

CARDIUM MINBUENSE, spec. nov., Pl. X, figs. 12, *a-c*, 13.

MEASUREMENTS.

	Length.	Height.	L/H.
Right valve	22·4 mm.	23·6 mm.	0·94

Though not unfrequent, well preserved shells are rare, so the measurements of only a single right valve could be taken. The shell is obliquely triangular in shape, higher than long, though the difference is not a great one as the index L/H is 0·94; it is rather inequilateral and strongly inflated. The umbo is high, tumid but strongly prosogyric, situated in the middle. The pedal region is short but broadly rounded, the siphonal one a little longer, but somewhat contracted and truncated. The anterior margin is long, rounded and passes in a broad sweep into the straight, dorsally bent ventral margin.

The posterior margin is rather long, straight or slightly convex, forming a sharp obtuse angle with the ventral margin. The cardinal margin is short, slightly curved and forms an obtuse angle with the posterior and anterior margin.

The ornamentation consists of 40 to 42 fine thread-like, rounded radiating ribs, separated by somewhat narrower interstices. Unfortunately all the specimens are much worn, and the result of this weathering is the appearance of a sculpture on the shell which is by no means primary, but only due to its internal structure. It is, however, quite certain that the ribs were round and set with minute granules—an ornamentation which, as may be well imagined, is easily rubbed off, and instead of it the laminous structure of the shell is exposed, imitating a kind of scaly ornamentation.

The hinge formula is as follows:—

Right valve La. (III) : I	C. 3a : 1	Lp. I :
Left valve La. II	C. : 2a : 2p	Lp. : II.

There are two anterior laterals LaI and LaIII, in the right valve of which the former is the larger of the two, LaIII being rudimentary, there is also a very strong, elongate posterior lateral representing LpI, which is much stronger than LaI; the laterals are slightly oblique, and a good distance from the cardinal teeth; on the dorsal side of both is a deep, long socket for the corresponding teeth of the left valve. C3a is small, thorn-like, C1 strongly curved upwards. In the left valve LaII and LpII are very strongly developed; in fact they appear to be stronger than the laterals in the right valve. C2a is strong, thorn-like, curved inwards; C2p is small, thorn-like.

Ligamental groove moderately long. Muscular scars and pallial impression not observed. Test thin, its thickness not exceeding 0·9 mm.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Aricia humerosa*, Thayetmyo.
Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—Its posteriorly accuminated shape and the rising ventral margin form good distinguishing features, even if the ornamentation cannot be observed. In well preserved specimens there can be no doubt, because the fine filiform ribs set with minute granules readily distinguish this species.

No living relative of this species could be found, and it probably represents a type extinct among the fauna of the Indian Ocean.

Family: *CYRENIDÆ*, H. and A. Adams.

Genus: CYRENA, Lamarck.

The following three species belong certainly to this genus though they exhibit a small difference with regard to the hinge, inasmuch as there is only one lateral, LaII and LpII in the left valve, while according to the general hinge formula there ought to be two laterals, *viz.*, LII and LIV.

As the hinge of *Cyrena* is very variable I do not think that this feature is of special importance. The only question would be, to which of the sub-sections into which this genus has been split up the specimens here described should be referred to. The sub-genus *Corbicula* is of course out of question, though it seems probable that at least two of the species had *Corbicula*-like ancestors. *Cyrena*, s. str., has the teeth more or less divided, a feature of which no trace has been noticed in the specimens here described, and from the remaining two, *Velorita* and *Batissa*, the former is out of question altogether, but the diagnosis as applied to the sub-genus *Batissa* seems to answer very well to the species here described.

The three species may be distinguished as follows :—

A. Test very thick, hinge very strong.

  a. Shell very large.

    1. *Cyrena* (*Batissa*) *kodoungensis*, spec. nov.

  b. Shell of moderate size.

    2. *Cyrena* (*Batissa*) *crawfurdi*, Noetling.

B. Test thin, hinge delicate.

    3. *Cyrena* (*Batissa*) *petrolei*, Noetling.

As already mentioned in my memoir on Miocene Fossils from Upper Burma, the second and third of these species are known since 1829 when they were first mentioned by Mr. Crawfurd,[1] who apparently collected at the same locality where I found the specimens here described. Dr. Buckland,[2] who described the fossil bones collected by Mr. Crawfurd, already recognized the generic position of these species, alluding to it as a *Cyrena*, without, however, giving a specific name. Nearly thirty years later Dr. Oldham [3] visited Yenangyoung, together with the members of the mission to Ava, but he searched in vain for the locality, which I re-discovered 67 years after it had first been mentioned.

It appears that none of these three species has a direct descendant or relative among the fauna of the Indian Ocean. *Cyrena kodoungensis* may perhaps be related to *Cyrena inflata* from the Nicobar Islands, yet it is also possible that *Cyrena gigantea* from the Philippine Islands is its nearest relative; on the other hand, it seems certain that *Cyrena crawfurdi* and *Cyrena petrolei* represent truly extinct types, their nearest relative being *Cyrena sumatrensis*, Sow., from Sumatra.

CYRENA (BATISSA) KODOUNGENSIS, spec. nov., Pl. XI, fig. 1.

Besides the two species afterwards described I collected fragments of a larger shell, which indicates by the character of the hinge that it belongs to the genus *Cyrena* (*Batissa*). Owing to the fragmentary state of the specimens, not much can be said about the shape of the valves; they were, however, very large; an incomplete specimen measures 75 mm. in height, while its length was probably larger still. The shell is very thick, the surface covered with coarse irregular striæ of growth, bearing deep marks of corrosion everywhere. The hinge is very strong and in a fragment of the left valve there is a low anterior lateral and three cardinals; the anterior cardinal is short, thick, the central one thick, elongated and the posterior one very long, but equally thin, the sockets are broad and deep. The above hinge would answer to the following formula :—

Right valve La. III : I	C. 3a : 1 : 3p.	Lp. ?
Left valve La. II	C. : 2a : 2p : 4p	Lp. ?

Geological occurrence.—

Zone of *Cyrena* (*Batissa*) *crawfurdi*, Yenangyoung.

[1] Crawfurd, Journal of an Embassy to the Court of Ava, London, 1829, page 829.

[2] *Ibid*, Appendix XIII, page 85; reprinted from the Transact. Geolog. Society, 1829.

[3] Yule, Narrative of the Mission to the Court of Ava, London, 1858, page 315.

Remarks.—I have first been inclined to consider this species merely as a gigantic variety of *Cyrena* (*Batissa*) *crawfurdi*, but on closer examination I abandoned this opinion. The latter species never exhibited anything of a similar size, and among the hundreds of specimens I examined, even the largest remained somewhat isolated with a height of 46mm., the majority of specimens being below this size; as the character of the surface seems also to differ, the specific independence of this species seems secured. Bœttger [1] states that hitherto no fossil *Cyrena* of the size of *Cyrena* (*Batissa*) *borneensis* described by him had been known. The species here described exceed even this largest known fossil *Cyrena* considerably, inasmuch as it measures though in a fragmentary state 75 mm. in height, while *Cyrena* (*Batissa*) *borneensis* measures only 64 mm. in height.

Cyrena (*Batissa*) *kodoungensis* represents therefore the largest known fossil *Cyrena*, and in regard to size, it certainly equals giants like the living *Cyrena* (*Batissa*) *gigantea* from the Philippine Islands or *Cyrena* (*Batissa*) *inflata* from the Nicobars.

The specimens are, however, too fragmentary to allow of a comparison, and though it is probable that there are living relatives of *Cyrena kodoungensis*, I refrain from expressing a definite opinion until better preserved specimens have been found.

CYRENA (BATISSA) CRAWFURDI, Noetling, Pl. XI, figs. 3, *a-b*, 4, *a-b*, 5, 5*a*, 6, *a-b*, 7, 8.

1895. *Cyrena* (*Batissa*) *crawfurdi*, Noetling, Marine Foss. from Mioc. of Upper Burma, Mem. Geolog. Survey of India, Vol. XXVII, pl. I, p. 9, pl. II, figs. 1-4, pl. III, figs. 1-1e.

MEASUREMENTS.

	Length.	Height.	Thickness.	L/H.		Length.	Height.	Thickness.	L/H.
1.	?	45·5 mm.	34·0 mm.	?	23.	32·0 mm.	27·0 mm.	18·8 mm.	1·18
2.	46·2 mm.	40·7 „	26·5 „	1·13	24.	31·4 „	27·4 „	19·5 „	1·14
3.	41·0 „	37·6 „	25·3 „	1·09	25.	31·0 „	27·0 „	17·0 „	1·13
4.	40·7 „	38·5 „	25·9 „	1·06	26.	29·4 „	26·4 „	16·0 „	1·11
5.	39·1 „	37·8 „	25·0 „	1·03	27.	29·1 „	25·3 „	17·3 „	1·15
6.	38·9 „	34·6 „	24·1 „	1·12	28.	28·9 „	23·6 „	16·6 „	1·22
7.	38·6 „	35·6 „	23·1 „	1·08	29.	28·2 „	24·3 „	16·0 „	1·16
8.	37·0 „	32·6 „	22·0 „	1·13	30.	25·6 „	23·8 „	15·4 „	1·07
9.	36·9 „	32·3 „	21·0 „	1·14	31.	27·0 „	23·0 „	16·0 „	1·17
10.	36·2 „	33·0 „	21·0 „	1·09	32.	26·9 „	22·5 „	15·3 „	1·19
11.	36·2 „	32·5 „	22·4 „	1·11	33.	25·6 „	22·3 „	15·3 „	1·14
12.	35·7 „	32·0 „	22·7 „	1·11	34.	24·6 „	21·4 „	16·1 „	1·15
13.	35·6 „	32·0 „	21·0 „	1·11	35.	23·9 „	21·6 „	15·4 „	1·10
14.	34·5 „	31·7 „	21·9 „	1·08	36.	23·8 „	21·4 „	15·0 „	1·11
15.	34·4 „	31·5 „	21·9 „	1·09	37.	22·0 „	20·3 „	14·7 „	1·08
16.	34·3 „	31·3 „	19·3 „	1·09	38.	21·3 „	19·5 „	14·1 „	1·12
17.	34·2 „	31·5 „	19·5 „	1·08	39.	21·0 „	19·4 „	11·5 „	1·08
18.	34·2 „	30·0 „	19·7 „	1·14	40.	19·2 „	17·5 „	11·7 „	1·09
19.	34·0 „	32·0 „	20·8 „	1·06	41.	15·7 „	13·7 „	9·1 „	1·14
20.	33·7 „	33·7 „	23·2 „	1·00	42.	14·0 „	12·5 „	7·9 „	1·12
21.	33·3 „	29·7 „	19·3 „	1·12	43.	13·3 „	12·0 „	7·4 „	1·10
22.	33·2 „	30·0 „	20·4 „	1·10					

[1] Eocänformation von Borneo, page 15.

The shell is of medium size; the largest specimen which has come under examination is unfortunately damaged at the posterior side, it cannot, however, have been smaller than 50·3 mm. in length. The shape of the shell varies little, having generally a sub-quadrangular form.

The index L/H does not exhibit a great range, as it varies from 1·00 to 1·22, the average being 1·107; within the above limits the chain is uninterrupted between 1·19 and 1·05, there being only two gaps at the beginning and the end as seen from the following table:—

Index . . .	1·00	1·01	1·02	1·03	1·04	1·05	1·06	1·07	1·08	1·09	1·10	1·11	1·12
Number of specimens	1	...	...	1	...	1	1	1	5	5	3	5	4
Index . . .	1·13	1·14	1·15	1·16	1·17	1·18	1·19	1·20	1·21	1·22	...	...	...
Number of specimens	3	5	2	2	1	1	1	...	...	1	...	...	...

If the specimens are arranged into three groups according to the size of the index L/H we see that there are—

5	specimens	having an	index from	1·00—1·07
32	,,	,,	,,	1·08—1·15
7	,,	,,	,,	1·16—1·22

The majority possess therefore an index between 1·08 and 1·15, while those showing a larger or smaller one are considerably in the minority.

The formula of variety should therefore be as follows:—

$$\text{var. } 23 \left| \begin{matrix} 1{\cdot}22 \\ \\ 1{\cdot}00 \end{matrix} \right.$$

The thickness varies considerably as there are strongly inflated valves, while others are more compressed; it seems, however, certain that the thickness increases in direct proportion with the size; the smallest specimens being the flattest, the largest the most inflated.

The umbo which is in front of the middle line is when preserved strongly inflated, obtuse, prosogyric; in most specimens, however, it is deeply corroded, in some instances the corrosion is so far advanced that the hinge is laid bare, and then a very curious feature is observed. In order to protect the hinge the animal secreted a secondary deposit of transparent chalk, which not only fills up the top of the sockets, but also coats the teeth, as may be seen from the figures. It is remarkable that the plane of corrosion does not run parallel with the striæ of growth, but cuts the latter at a pointed angle. The marks of corrosion are always concave with sharp raised rims, exhibiting in a fine way the concentric structure of the test.

The pedal region is generally very short and rounded; in some varieties it may, however, not be so strongly contracted, the siphonal region is always expanded and obliquely truncated. The anterior margin is rounded and passes gradually into the slightly curved ventral margin, which forms about a right angle the corner of

which is rounded off, with the slightly convex posterior margin. The cardinal margin is long, strongly curved, its posterior part forms a very obtuse angle with the posterior margin while its anterior part passes gradually into the anterior margin.

The ligament was apparently strong, lodged in a long and deep groove, behind the umbo.

The ornamentation varies greatly during the different stages of growth; during the nealogic stage, which owing to the corrosion of the umbos, is, however, only rarely observed, and which included specimens of 7 mm. in height and under, the whole surface was completely covered with very regular concentric ribs, of which there may have been at least 25; the ribs were rounded, equidistant and separated by interstices of about the same breadth. This sculpture terminated very suddenly and in later stages the anterior region only exhibits some sort of ornamentation; it consists of deeply engraved, more or less closely set concentric furrows, producing coarse, irregular wrinkles between them; on the larger, posterior region of the shell these furrows become effaced, and only a few remain in the shape of strongly marked striæ of growth, otherwise the surface is smooth. There is of course ample space for variation and no two specimens are exactly alike, the wrinkles on the anterior region being sometimes more numerous, or they take the shape of broad, nearly lamellar concentric ribs, but the chief features remain always the same.

The hinge is very strongly developed and composed as follows:

(*a*) *Right valve.*

1. Anterior lateral teeth.

There are two anterior laterals, LaI and LaIII, both elongate and strongly opisthocline; the ventral LaI is considerably stronger and thicker than the dorsal LaIII; both are separated by an elongate socket which is broad and deep at its posterior part, but suddenly contracts to a narrow furrow; the ventral side of the socket is covered with numerous, fine, transverse, parallel plications.

2. Cardinal teeth.

The anterior cardinal C3a is very short, knob-like, perhaps slightly opisthocline; on its posterior side is a broad and deep socket, which is followed by the short, thick, slightly prosocline C1; on its posterior side is a broad and deep socket followed by the elongate, but rather thin, strongly prosocline C3p, which has on its posterior side a long and deep socket. Then follows the broad ligamental nymphe.

3. Posterior lateral teeth.

There are two posterior laterals, the ventral one of which LpI is rather long, thick and strongly prosocline; LpIII is almost rudimentary and separated from the former by a very elongate socket, which is broad at its anterior end, but narrows gradually in posterior direction, the ventral side of the socket is covered with numerous, fine, transverse plications.

(*b*) *Left valve.*

1. Anterior lateral teeth.

There is one elongate, strongly opisthocline anterior lateral LaII, which is rather thick at its posterior, but very thin at its anterior extremity: its dorsal side is covered with fine transverse plications; there is a shallow socket on either side.

2. Cardinal teeth.

The anterior cardinal C2a is rather short, opisthocline, having a shallow socket on its anterior, and a broad and deep socket at its posterior side; then follows the strongly prosocline stout C2p, which has a broad and deep socket on its posterior (dorsal) side; this is followed by a thin, low, elongate, strongly prosocline C4p on the edge of the ligamental nymphe.

3. Posterior lateral teeth.

There is one elongate, strongly prosocline posterior lateral, LpII, which is broad and thick at its anterior, thin and lamellar at its posterior end, having its dorsal side covered with fine transverse plications; there is a deep socket on its dorsal and a shallow on its ventral side.

The hinge formula is, therefore, as follows:—

Right valve	La. III : I	C. 3a : 1 : 3p :	Lp. III : I.
Left valve	La. II	C. : 2a : 2p : 4p	Lp. II.

Geological occurrence.—

Zone of *Cyrena* (*Batissa*) *crawfurdi*, Yenangyoung.

Remarks.—*Cyrena* (*Batissa*) *crawfurdi* is easily distinguished from the following species by its smaller index L/H, the average being 1,107; the shell of *Cyrena* (*Batissa*) *crawfurdi* is, therefore, much less transversely elongated, and looks much higher. This feature can, however, only be well seen when the umbo is not corroded, as otherwise it becomes rather indistinct.

The umbo of *Cyrena* (*Batissa*) *crawfurdi* is more anteriorly situated than in the following species where it is more central, a character which can, however, also only be observed in well preserved specimens.

Generally speaking, *Cyrena* (*Batissa*) *crawfurdi* is much more inflated than *Cyrena* (*Batissa*) *petrolei*, although this character becomes rather indistinct in young specimens and obscure when, as is frequently the case, the specimens are somewhat squashed.

The best distinguishing features ore the great thickness of the shell as well as the exceedingly strong hinge; in no instance does *Cyrena* (*Batissa*) *petrolei* come anywhere near to this species in either feature, so that fragments even may be determined.

Among living species *Cyrena* (*Batissa*) *sumatrensis*, Sow., exhibits such a great similarity with regard to the general shape, that notwithstanding the apparent differences as exhibited in the hinge as drawn in Reeve's monograph of the genus *Cyrena*, a relationship with either this or the following species is highly probable. Unfortunately I have no specimens of *Cyrena* (*Batissa*) *sumatrensis* for comparison, in order to decide how far the features by which the hinge of that species seems to differ from that of *Cyrena* (*Batissa*) *crawfurdi* are constant or not.

CYRENA (BATISSA) PETROLEI, Noetling, Pl. XI, figs. 9, *a-c*, 10, 11.

Cyrena (Batissa) petrolei, Noetling, Marine Foss. from Mioc. of Upper Burma, Mem. Geolog. Survey of India, Vol. XXVII, pt. i, p. 11; pl. II, figs. 5-5e, pl. III, figs. 2-3.

MEASUREMENTS.

	Length.	Height.	Thickness.	L/H.		Length.	Height.	Thickness.	L/H.
1.	41·0 mm.	36·4 mm.	20·0 mm.	1·13	7.	35·6 mm.	30·9 mm.	27·1 mm.	1·15
2.	40·5 „	36·0 „	21·1 „	1·12	8.	21·1 „	18·1 „	9·5 „	1·17
3.	40·1 „	34·4 „	19·7 „	1·13	9.	20·2 „	16·6 „	9·1 „	1·21
4.	40·0 „	40·0 „	[illegible] „	1·00	10.	19·3 „	15·8 „	9·1 „	1·21
5.	38·2 „	31·6 „	20·5 „	1·20	11.	18·9 „	14·8 „	8·9 „	1·27
6.	37·1 „	32·2 „	18·1 „	1·15	12.	14·0 „	12·0 „	7·2 „	1·16

The inequilateral shell is of medium size, probably in the average a little smaller than the former species, being generally of elliptical shape. Unfortunately only a small number of specimens have come under examination. I therefore do not know how far the indices above given represent the true range of variety. To judge from the above figures the formula of variety ought to be—

1·27
var. 28 |
1·00

The range of variety would, therefore, be slightly larger than that of the former species, and it is quite evident that as far as may be judged from the somewhat scanty material the more elongate varieties preponderate. If we arrange in the same manner as before there would be:

1 specimen	having an Index from	1·00	to 1·07
5 specimens	„ „	1·08	„ 1·15
6 „	„ „	1·16	„ 1·27

Var. 1·16—1·27 are apparently in the majority, and the tendency of variation is rather in favour of the production of elongate specimens than otherwise.

The thickness varies not much; the shell is moderately inflated; in fact small shells might be called very flat and laterally compressed.

The umbo which is slightly in front of the middle, is slightly tumid, very much depressed and hardly prominent; in many specimens it is deeply curved, exhibiting the same features as described in the former species. The pedal region is slightly expanded and rounded off, the siphonal region is expanded, rounded or obscurely truncated.

The anterior margin is rounded and passes gradually into the slightly curved ventral margin which in its turn passes again into the slightly rounded posterior margin; cardinal margin strongly curved passing gradually into the anterior and posterior margin. Ligament strong, situated in a long and narrow groove behind the umbo and supported by strong nymphes.

The ornamentation is the same as in the former species. During the nealogic

stage the shell was covered with very regular concentric ribs, which disappear later on to be replaced by coarse, concentric wrinkles on the anterior and coarse striæ of growth on the posterior region.

The hinge is much less strongly developed than in the former species; in fact the more delicate hinge is one of the strongest distinguishing features of this species, although the formula being the same as in the former species, *viz.*—

Right valve La. III : I	C. 3a : 1 : 3p :	Lp. I : III.
Left valve La. II:	C. : 2a 2p : 4p	Lp. II.

The difference in the strength of the laterals of both valves is as well marked as the striated dorsal face of LaI and LpI.

The test is, compared with that of the former species, very thin, its thickness being 2 mm. and under.

Anterior muscular scars strongly marked, but small; posterior one apparently much less marked; pallial line pretty distant from the sharp margin, strongly marked in its anterior, less so in its posterior part.

Geological occurrence.—

Zone of *Cyrena* (*Batissa*) *crawfurdi*, Yenangyoung.

Remarks.—I have hesitated for a long time in separating this species from *Cyrena* (*Batissa*) *crawfurdi* because both species seemed to be so nearly alike that they appeared merely as varieties. The following reasons have, however, induced me to consider it as specifically different from that species, *viz.*:—

1. Its shape is generally more elongate, that is to say, while the average index L/H in *Cyrena* (*Batissa*) *crawfurdi* is 1,107 it is 1,154 in this species.
2. The shell is much less inflated.
3. The hinge though being the same as regards number of teeth is much more delicate.
4. The test is very much thinner.

Of course the remarks made about the living relative of *Cyrena* (*Batissa*) *crawfurdi* apply to this species also, as it is extremely difficult to say which of two species so closely allied as *Cyrena* (*Batissa*) *crawfurdi* and *petrolei* is the nearest relative of a living species when that species is only known from a figure, which is not quite sufficient for such a purpose.

Family : *CYPRINIDÆ*, H. & A. Adams.

Genus : MEIOCARDIA, H. & A. Adams, 1856.

Shell equivalve, inequilateral, ventricose, more or less triangular in shape, umbones prosogyric, but turned away from each other. An acute strong keel runs from the umbo towards the posterior corner, dividing the surface in a more or less tumid anterior part, and a more or less inclined concave posterior

part, both of which differ in ornamentation. On the anterior portion there are concentric, regular ribs, varying in strength in the different species, separated by sharply engraved furrows; on the posterior part there are only very thin concentric striæ, separated by similar furrows. Ligamental groove external, narrow, anteriorly furcate. The hinge consists of a large, elongate, curved, tripartite cardinal and a very long narrow posterior lateral tooth in the right valve, while in the left valve there is a low, short anterior, a curved, elongated posterior cardinal and an elongated lateral tooth. Pallial impression not sinuated, always ill-marked.

The brothers Adam have already recognised that a certain number of shells which had been included in the genus *Isocardia* (*Bucardia*) form by their more or less triangular, strongly carinated valves, a natural group, which had better be separated under a special name. The diagnose of the new sub-genus *Meiocardia* thus established is, however, very insufficient, particularly from a palæontological point of view, as it runs as follows: "Shell with the surface of the valves concentrically grooved, not covered with an epidermis."

To my knowledge Dr. Woodward [1] was the first who amended this diagnosis by adding: "Valves strongly carinated at the posterior end, forming a prominent acute diagonal ridge."

By most modern writers, like Fischer and Tryon, the original view of the brothers Adam has been accepted, but I think that *Meiocardia* may be considered as a full genus, particularly as it includes a number of fossil species which seem to have a wide distribution particularly in the European Tertiary formation.

I am unable to say why v. Kœnen includes a species like *Meiocardia sacki* in the genus *Anisocardia*, Munier-Chalmers. Quite apart from the fact that in the generical diagnosis of this genus it is stated, "pas de caréne postérieure," the name *Meiocardia* would deserve preference, because it was established in 1856 while *Anisocardia* was established in 1863.

The Miocene of Burma has yielded two species which may be distinguished as follows:—

A. Anterior part of surface covered with very fine concentric striæ, not fewer than 10 to the millimetre.

1. *Meiocardia protovulgaris*, spec. nov.

B. Anterior part of surface covered with coarse concentric wrinkles, not more than 2 to the millimetre.

2. *Meiocardia metavulgaris*, spec. nov.

The above apparently proves that the oldest species exhibits the finest, while the youngest, *Meiocardia metavulgaris*, exhibits the coarsest ornamentation. *Meiocardia sub-cumingii*, Woodward, from Sumatra exhibits a still coarser ornamentation than *Meiocardia metavulgaris*, there being one rib to the millimetre,

[1] Geolog. Magaz., New Series. Decad. II, Vol. VI, 1879, p. 389.

and if any inference were to be drawn from this, it would be, that it occurs in beds younger than the zone of *Meiocardia metavulgaris* of Singu.

The recent species *Meiocardia vulgaris, moltkiana* and *lamarkii* have a still coarser ornamentation, and the development of the genus as represented in further India and China would, therefore, be in ascending order as follows :—

Meiocardia protovulgaris, Miocene.

|

Meiocardia metavulgaris, Miocene.

|

Meiocardia sub-cumingii, Pliocene.

Meiocardia vulgaris, *Meiocardia moltkiana*, *Meiocardia lamarkii*, Recent.

In Europe the genus *Meiocardia* seems to be limited to the Eocene and Oligocene periods; no representatives seem to occur in the younger Tertiaries; during that time it seems to have migrated to the Indian Tertiary seas, and having migrated further towards east, it is at present only found in the China Seas, but not in the Indian Ocean.

There are, however, in the Cretaceous formation certain species like *Trapezium trapezoidale*, F. Roemer, spec., which to judge from the shape of the shell might probably be a true *Meiocardia*. I am, however, unable to verify this view.

MEIOCARDIA PROTOVULGARIS, spec. nov, Pl. XII, fig. 1, *a-e*.

MEASUREMENTS.

	Length.	Height.	Thickness.	L/H.
Right valve	24·3 mm.	21·0 mm.	8·4 mm.	1·15

There is only a single right valve which has come under examination, but being beautifully preserved, a full description of the species can be given.

The shell is inequilateral, triangular in shape, of medium size and only slightly longer than high; the umbo is inflated, but strongly incurvated, anteriorly situated, nearly terminal. The pedal region of the shell is short and rounded, the siphonal one attenuated. The anterior margin is rounded and passes gradually into the nearly straight, ventral margin which is just perceptibly sinuated towards its posterior end. The latter joins the straight and short posterior margin at a sharp pointed corner, forming an angle of about 70°. Cardinal margin strongly curved. A sharp keel runs from the umbo towards the posterior corner, dividing the surface into a larger, evenly inflated anterior portion, and a smaller, concave posterior one, which drops nearly perpendicularly. The anterior portion of the surface is covered with numerous, very fine concentric striæ, separated by sharply engraved interstices. There are not fewer than ten of these lines to the millimetre. On the posterior portion of the shell the lines become indistinct and effaced. The ligamental groove is long and narrow, extending up to the umbo.

The hinge is composed as follows :—

(*a*) *Right valve.*

There is rather a large, angular tooth the posterior end of which is turned upwards so as to form an obtuse angle, the apex of which is turned ventrally, slightly in front of the umbo and close to the anterior margin. The anterior side is a little longer and slightly notched; on the anterior (dorsal) side is a deep triangular socket followed by a minute granular tooth close to the margin; a comparison with the recent ***Meiocardia vulgaris*** proves that the same elements are developed as in that species and that the posterior side of the angular tooth represents LaI: the anterior horizontal branch is composed of C3a and C1, while the granular tooth on the dorsal side of the socket represents LaIII. The only difference noticed would be that in the Miocene species C1 is shorter than the amalgamated C3a and LaIII, while the reverse takes place in the recent species.

Separated by a short notch follows a lamellar strongly curved, prosocline tooth, having a deep socket on both ventral and dorsal side; this tooth is divided by a shallow furrow and represents C3p and C5p; its only difference from the similar tooth of the recent species consists of its being shorter and stronger curved. Then follows the ligament and behind it the long lamellar posterior lateral LpI separated by a narrow socket from the much weaker LpIII; in the recent species the features are exactly alike.

(*b*) *Left valve.*

There is a similar trifid anterior tooth close to the anterior margin, but in harmony with the right valve, the posterior branch representing C2a is rather small while LaII and LaIV are much stronger than in the living species. C2p is short, lamellar, prosocline and strongly curved, separated by a long narrow socket on its dorsal side from Ca4p, which is equally strongly curved. Then follows the ligament and behind it the long lamellar LpII having a long socket on its dorsal side.

The hinge formula is therefore as follows :—

Right valve	La. III : I	C.	3a	:	1	:	3p	:	5p	Lp. III : I.
Left valve	La. IV : II	C.	2a	:	2p	:	4p	:		Lp. II.

Geological occurrence.—

Zone of ***Parallelipipedum prototortuosum***, Kama.

Zone of ***Pholas orientalis***, Thayetmyo.

Remarks.—This pretty species is easily distinguished from the younger ***Meiocardia metavulgaris*** by the fine, thread-like lines constituting the ornamentation of the anterior part of the surface. It is also possible, although I cannot state it with certainty, that it differs from ***Meiocardia metavulgaris*** by its higher, less elongated shape. The index L/H=1·15 seems at least to indicate the feature which, if confirmed by future researches, would also form a distinctive character. Without attaching however too much weight to this character, as the index L/H always varies within certain limits, I wish to point out that the figures obtained from the measurement of ***Meiocardia metavulgaris*** seems to indicate that

in the younger stages the index L/H was a smaller one; in other words, that the shape of the younger specimens of this species was very similar to the full grown, geologically older *Meiocardia protovulgaris*.

MEIOCARDIA METAVULGARIS, spec. nov., Pl. XII, figs. 2, *a-d*, 3, 3*a*.

MEASUREMENTS.

	Length.	Height.	Thickness.	L/H.
1.	31·5 mm.	?	?	...
2.	29·2 „	21·8 mm.	?	1·34
3.	28·6 „	?	?	...
4.	26·5 „	19·7 mm.	15·5 mm.	1·34
5.	25·2 „	19·2 „	?	1·31
6.	22·0 „	17·0 „	?	1·30
7.	18·9 „	14·2 „	?	1·33
8.	15·5 „	12·7 „	5 mm.	1·22

The shell is equivalve, very inequilateral, of medium size and considerably longer than high. The above measurements seem to indicate that the height, which is roughly speaking about three-fourths of the length, changes somewhat with the size of the shell. In the smallest specimen the index is the lowest, that is to say, the height is over eight-tenths of the length, and with advancing size the height decreases till it is less than three-fourths of the length. The umbo is inflated, pointed, strongly involuted and somewhat depressed, situated on the anterior third of the length. The pedal region of the valves is contracted and rounded off, the siphonal expanded and attenuated. Anterior and ventral margin rounded, passing gradually into each other; posterior margin straight, oblique, forming a sharp angle of 70° to 80° with the ventral margin; hinge margin slightly curved, forming an obtuse angle with the posterior margin. A sharp keel runs from the umbo towards the junction of ventral and posterior margin dividing the shell into two regions distinguished by difference of ornamentation. The pedal region is large, strongly gibbous, and covered with deeply engraved, regular concentric, closely set furrows terminating at the keel. These furrows produce flat, concentric ribs the surface of which is ventrally inclined. The furrows are generally equidistant, but sometimes they follow each other a little closer. In full grown specimens the regular ribbing becomes indistinct towards the ventral margin and is replaced by numbers of fine, a little irregular striæ of growth.

The siphonal region is steeply, nearly perpendicularly inclined; an indistinct rounded keel runs from the umbo towards the junction of posterior and hinge margin. In front of this keel the posterior region is deeply excavated. The ornamentation consists of very fine, regular concentric striæ, which are very closely set, and divided by interstices of about the same breadth. There are about three times the number of striæ on the posterior, than there are ribs on the anterior region. The ligamental groove is long and narrow, furcate anteriorly. Hinge not observable.

Muscular scars and pallial impression indistinct. The test thin, measurements with the micrometer screw gave 0·65 to 0·80 mm. in the umbonal and posterior parts,

1·02 to 1·1 mm. in the anterior parts. Owing to the thinness of the test the posterior keel is always well visible on casts.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.

Zone of *Meiocardia metavulgaris*, Singu.

Remarks.—The characters of the hinge being not observable when I first discovered this shell, I believed it to be a *Cypricardia* judging from its general appearance. I, therefore, termed the bed in which it is of so frequent occurrence *Cypricardia* bed, a name which must now be changed.

From the Indian Tertiary formation no similar species has hitherto been described, but from the Miocene of Java and Sumatra two species are known, one of which is unquestionably nearly allied to *Meiocardia metavulgaris*.

Under the name of *Meiocardia sub-cumingii*, Dr. Woodward [1] has described a species which exhibits features so similar to the species from Burma that I first considered both to be identical. The Sumatran species appears to be however higher, and what is of more importance, the concentric wrinkles are much coarser. Considering that the chief difference of *M. protovulgaris* and *M. metavulgaris* consists in the coarser sculpture of the latter, this feature appeared in a different light, and until actual comparison would prove that the species are identical, I consider them as different.

From Java, Martin [2] has described under the name of *Isocardia moltkiana*, Lam. (?), a cast, which to judge from the general shape might be referred to either of the above species. As it is, however, in rather a fragmentary state of preservation, none of the chief distinguishing features being known, I refrain from any comparison.

The nearest living relative is *Meiocardia vulgaris*, Lam., of which I luckily have a species for comparison. It will be seen at once that the chief distinguishing feature consists in the much coarser ornamentation of the living species; the concentric ribs which were just indicated in *Meiocardia protovulgaris* and which have developed into strong concentric ribs in *Meiocardia metavulgaris*, are represented in the living *Meiocardia vulgaris* by broad, rounded, rather coarse ribs.

Family : *PETRICOLIDÆ*, Stoliczka.

Genus : PETRICOLA, Lamarck.

PETRICOLA INCERTA, spec. nov., Pl. XII, figs. 4, 5.

MEASUREMENTS.

	Length.	Height.	L/H.
Left valve	27·3 mm.	13·4 mm.	2·04

The shell is of moderate size, transversely elongate, sub-rectangular, the length

[1] Geolog. Magaz., New. Ser., Dec. II, Vol. VI, 1879, p. 389, pl. X, fig. 10.

[2] Nachtr. zu den Tert. Sch. auf Java, Erster Nachtrag. Beitr. zur Geol. Ost. Asiens, Vol. I, 1883, p. 249, pl. XIII, fig. 45.

always exceeding the height considerably ; the material under examination did not allow for accurate measurements, but it appears that the index L/H was rather large.

The umbo is low, depressed, situated considerably in front of the middle line; the pedal region is, therefore, rather short, rounded, the siphonal region elongate, broad and slightly attenuated.

The anterior margin is broadly rounded and passes gradually into the elongate, almost straight, or perhaps slightly convex ventral margin, which in its turn passes gradually into the short, broadly rounded posterior margin; the cardinal margin is long, curved, inequilateral, the anterior short portion passes gradually into the anterior margin, while the posterior portion is considerably longer, straight, and slightly ventrally inclined.

The surface is apparently smooth, except for numerous, a little irregular concentric striæ of growth.

Test apparently very thin, not exceeding 0·28 mm. in thickness. Internal characters and characters of the hinge not known.

Geological occurrence.—

Zone of *Pholas orientalis*, Thayetmyo.

Remarks.—Owing to the entire absence of any definite internal characters the generic position of this genus must be considered as provisional only. I have, however, assumed from the general outline and the association with another boring Mollusk, *Pholas orientalis*, that the possibility of this species belonging to the genus *Petricola* is not improbable.

The specific characters are too indefinite to allow of any comparison with either living or fossil species, all I can say is that no species exhibiting a similar shape and surface ornamentation has been described either from Western India or Java and Sumatra.

Family: *VENERIDÆ*, Stoliczka.

Genus: VENUS, Linné.

Only two species of the genus, so largely distributed in the Tertiary series have been described. This may chiefly be due to the fact that numerous other species, if their internal characters had not been known, would have probably been ranged under this genus. As it is, the character of the hinge of the two species described is unknown, and it is merely from external evidence that their generic position was fixed, although it is not very probable that it is wrong. Both species belong to that group of *Venus* which is distinguished by a lattice-like ornamentation. They are easily distinguished as follows:—

A. Shell triangular.
    1. *Venus protoflexuosa*, spec. nov.
B. Shell transversely oval.
    2. *Venus granosa*, Sow.

One of these species, *Venus granosa*, is so similar to the living *Cytherea sowerbyi*, Reeve, that there can be hardly any doubt as to their identity; on the other hand *Venus protoflexuosa* apparently represents a type which is extinct among the present fauna of the Indian Ocean, though it appears certain that its nearest relative is represented by *Venus flexuosa*, Linné, from China.

VENUS PROTOFLEXUOSA, spec. nov., Pl. XII, figs. 6, 6a.

MEASUREMENTS.

Length.	Height.	L/H.
15·0 mm.	1·27 mm.	1·18

Though not unfrequent, well preserved shells are rare and only the measurements of one could be taken.

The shell is triangular in shape, the length being only slightly in excess of the height; the index L/H is therefore apparently small; it is moderately inflated and rather inequilateral.

The umbo is inflated, prosogyric, situated at about the middle line.

The pedal region is short, rounded, the siphonal one slightly longer, acuminated and truncated.

Anterior margin broadly rounded, passing gradually into the straight ventral margin, which forms a sharp pointed angle with the posterior margin; the latter is rather long, oblique; cardinal margin apparently short.

A strong sharp keel runs from the umbo towards the posterior corner, the surface dropping steeply behind it.

The surface is covered with numerous fine, radiating ribs, which are flat and separated by linear interstices; these are crossed by sharp, raised, equidistant concentric ribs, which are separated by broad interstices, thus producing a decussate ornamentation.

Characters of the hinge and internal characters of the shell not known.

Geological occurrence.—

Zone of *Pholas orientalis*, Thayetmyo.

Remarks.—This species has a very close relative in *Venus trigonalis*, Mart., from Java, and I have hesitated for some time whether it had not been better included under this name. It appears, however, that *Venus trigonalis* is of a more orbicular shape, having the posterior area less steeply inclined and a longer cardinal margin. These differences which are well expressed in Professor Martin's figure seemed to be sufficient to justify a specific separation, although the close relationship of the two species is unquestionable.

Among the living species *Venus flexuosa*, Lin., from China seems to be the next relative; general shape and ornamentation of the Miocene species agree very well with Reeve's figure of *Venus flexuosa*, but having unfortunately no specimen for comparison, I am unable to say how far my view is correct. The chief differ-

ences would be a larger shell and a coarser ornamentation, a feature which is quite in harmony with the observation made in other species, and the probability that *Venus flexuosa* is a descendant of the Miocene *Venus protoflexuosa* is, therefore, very great.

VENUS GRANOSA, Sowerby, Pl. XII, figs. 7, 7a.

1840. *Venus granosa*, James de Carle Sowerby, Transact. Geol. Soc., 2nd ser., Vol. V, pl. V, fig. 7.

Unfortunately, as only one specimen which is partly damaged has come under examination, no accurate measurements could be taken, but the characters of the surface are sufficiently well preserved to allow for determination.

The shell is almost orbicular in shape, and as the length apparently was not greatly in excess of the height, the index L/H must have been rather small; it is moderately inflated and slightly inequilateral.

The umbo is a little tumid, but low, prosogyric and slightly in front of the middle line. The pedal region is short, rounded, somewhat contracted, the siphonal region a little longer, broad and rounded.

Anterior, ventral and posterior margin form an almost complete circle; cardinal margin moderately curved, inequilateral, the shorter anterior portion passing gradually into the anterior margin, the longer, slightly convex, posterior portion forming a very obtuse angle with the posterior margin.

The ornamentation consists of numerous, fine, raised, lamellar concentric ribs following at regular intervals, which slightly increase in height towards the ventral margin. These ribs are crossed by numerous, low, rounded radiating ribs separated by linear interstices; these are chiefly marked in the intervals between the concentric ribs, while the only effect produced on the latter is of slightly notching them. The concentric sculpture predominates therefore over the radiating one; margin finely crenulated.

Characters of the hinge and internal features not observed.

Geological occurrence.—

Horizon unknown. Miocene near Prome.

Remarks.—The geological horizon of this species is not known with certainty; to judge from the rock it comes most probably from or near the zone of *Cytherea erycina*.

The species here described is so very similar to *Cytherea sowerbyi*, from the Indian Ocean, that I failed to discover any difference; it may perhaps be that the recent *Cytherea sowerbyi* has a slightly larger index L/H, but as the specimen under description is unquestionably somewhat squashed, I do not want to put too much stress on this feature, considering that in other regards the ornamentation is exactly the same.

Under the name of *Venus granosa*, Sowerby described a species which is probably closely allied if not identical with *Cytherea sowerbyi*. The figure as well as the description being, however, very insufficient, only actual comparison with

Sowerby's type specimen will enable this question to be settled. If *Venus granosa*, Sowerby, and *Cytherea sowerbyi*, Reeve, sp., were identical, preference should be given to that name which is the older.

Genus: CYTHEREA, Lamarck.

The two species here described as belonging to the genus *Cytherea*, s. s., can be distinguished as follows :—

A. Shell large, surface covered with broad flat concentric ribs separated by linear interstices.

1. *Cytherea erycina*, Favanne.

B. Shell small, surface seemingly smooth, but exhibiting under the magnifying lens numerous, finely engraved concentric striæ.

2. *Cytherea yomaënsis*, spec. nov.

There can be hardly any doubt that *Cytherea erycina* is identical with the species of that name inhabiting the Indian Ocean ; on the other hand *Cytherea yomaënsis* represents an extinct type of which, however, no relatives could be traced.

CYTHEREA ERYCINA, Favanne, Pl. XII, figs. 9, 9*a*, 10, 10*a*, 11, 11*a*, 12, *a-b*.

Dione erycina, Reeve, Monograph of the Genus *Dione*, Pl. I, fig .3.
Cytherea promensis, Theobald Ms.

MEASUREMENTS.

(*a*) Right valve.				(*b*) Left valve.			
	Length.	Height.	L/H.		Length.	Height.	L/H.
1.	57·8 mm. .	47·2 mm. .	1·22	1.	56·7 mm. .	42·4 mm. .	1·33
2.	56·6 ,, .	46·0 ,, .	[illegible]	2.	56·7 ,, .	41·6 ,, .	1·36
3.	55·0 ,, .	40·8 ,, .	1·34	3.	55·6 ,, .	41·5 ,, .	[illegible]
4.	50·2 ,, .	37·6 ,, .	1·32	4.	55·0 ,, .	41·0 ,, .	1·34
5.	50·0 ,, .	39·0 ,, .	1·28	5.	55·0 ,, .	40·0 ,, .	1·37
6.	49·6 ,, .	39·2 ,, .	1·26	6.	53·5 ,, .	40·0 ,, .	1·31
7.	48·4 ,, .	36·8 ,, .	1·31	7.	50·5 ,, .	38·2 ,, .	1·33
8.	47·0 ,, .	36·1 ,, .	1·33	8.	49·3 ,, .	37·6 ,, .	1·31
9.	46·1 ,, .	35·4 ,, .	1·31	9.	49·3 ,, .	31·1 ,, .	1·30
10.	46·6 ,, .	35·6 ,, .	1·31	10.	47·7 ,, .	36·2 ,, .	1·31
11.	46·0 ,, .	34·1 ,, .	1·32	11.	43·2 ,, .	32·0 ,, .	1·35
12.	45·0 ,, .	33·8 ,, .	1·33	12.	39·6 ,, .	30·5 ,, .	1·29
13.	45·0 ,, .	34·0 ,, .	1·32	13.	37·3 ,, .	26·4 ,, .	1·41
14.	45·0 ,, .	33·0 ,, .	1·36	14.	37·1 ,, .	29·7 ,, .	1·25
15.	44·1 ,, .	37·5 ,, .	1·17	15.	36·4 ,, .	27·7 ,, .	1·31
16.	42·4 ,, .	32·5 ,, .	1·30	16.	36·3 ,, .	28·1 ,, .	1·29
17.	29·1 ,, .	22·5 ,, .	1·29	17.	34·0 ,, .	25·3 ,, .	1·34
18.	27·3 ,, .	20·0 ,, .	1·36	18.	30·2 ,, .	23·5 ,, .	1·28

This species belongs to the largest shells known from the Miocene of Burma ; as will be seen the largest specimen measures nearly 58 mm. in length, it is transversely elliptical in shape, the length exceeding always the height.

The index L/H does not exhibit a great amplitude, as it varies from 1·17 to 1·41, the mathematical average would therefore be 1·29, but the calculated average is 1·319.

If the specimens measured above are arranged according to the size of the index, the following table will be obtained :—

Index	1·17	1·18	1·19	1·20	1·21	1·22	1·23	1·24	1·25	1·26	1·27	1·28	1·29	1·30
Number of specimens . .	1	...	...	...	...	3	...	...	1	1	...	3	2	2
Index		1·31	1·32	1·33	1·34	1·35	1·36	1·37	1·38	1·39	1·40	1·41		
Number of specimens . .		7	5	2	3	1	3	1	...	...	...	1		

It will be seen that the chain is nearly uninterrupted between 1·25 and 1·57, and we may take it that the greatest number of specimens will have an index within these limits; those having a smaller and higher index are so few, that we may consider them as rare exceptions. The above figures seem, however, to indicate that the tendency of variation is more towards the development of more orbicular than of elongate specimens.

The formula of variation is therefore as follows :—

$$\text{var. } 25 \begin{matrix} 1{\cdot}41 \\ | \\ 1{\cdot}17 \end{matrix} \quad \text{av.} \begin{cases} 1{\cdot}290. \\ 1{\cdot}319. \end{cases}$$

Far the greatest number of specimens, *viz.*, 15 or 41·6°/₀ of the total number are grouped between indices 1·30 and 1·33, that is to say, around the calculated average index, a fact which is quite in harmony with the result obtained from the study of the varieties of other species.

The shell is moderately and uniformly inflated; no measurements could however be taken with regard to the thickness, as the state of preservation was in all cases such that figures would have been very unreliable.

The umbo is pointed, but low and depressed, strongly prosogyric, and situated not far behind the anterior margin ; the shell is therefore rather inequilateral.

The pedal region is short, rounded, the siphonal one elongated and accuminated.

The anterior margin is short, rounded and forms a broad sweep with the strongly convex, ventral margin ; the posterior margin which is short, slightly convex, forms an obtuse angle, the corner of which is rounded off, with the ventral margin and passes gradually into the posterior part of the cardinal margin. The cardinal margin is very long, angularly broken, the anterior part being slightly concave and much shorter than the convex posterior one.

The lunula is rather small, slightly concave, circumscribed by a sharp furrow. The ornamentation consists of numerous, broad but flat concentric ribs, separated by linear deeply engraved interstices ; ribs and interstices are chiefly confined to the anterior region of the surface, where the former become frequently slightly raised ; in posterior direction the ribs and interstices become effaced, and the posterior region is only covered with fine concentric striæ of growth ; there is, however, no general rule as to the termination of the ribs ; in some specimens they cover nearly the whole surface while in others they extend only over the anterior half.

The hinge has not been observed.

The muscular impressions were very strongly marked, there was a strong ridge on the posterior side of the anterior scar.

The pallial impression is strongly marked, the sinus deep and angular.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.

Zone of *Pholas orientalis*, Thayetmyo.

Zone of *Cytherea erycina*, Prome.

Remarks.—This species seems to be so frequent in a certain bed as to exclude nearly all other species, and Mr. Theobald has therefore attributed a great stratigraphical importance to the *Cytherea promensis* bed. *Cytherea erycina* is easily distinguished from all the others by its size and by its ornamentation; with regard to size only *Dione amygdaloides* might perhaps be compared to it, and at the first glance it may seem as if both species were identical, on closer examination it will, however, be seen that this species never exhibits the regular flat and broad concentric ribs on the anterior region, having instead of them, coarse irregular striæ of growth, with irregular wrinkles between them. As I never noticed any specimens which by the character of their ornamentation might form connecting links between *Cytherea erycina* and *Dione amygdaloides* I considered it better to describe them as separate species though they are unquestionably closely allied.

This species has been frequently alluded to by Mr. Theobald under the name of *Cytherea promensis*, but on studying its living relatives and on comparing the living *Cytherea erycina*, Fav., from Ceylon it was obvious that the specific name "*promensis*" had to be cancelled. It must, however, be mentioned that old and large specimens of the living *Cytherea erycina* lose the peculiar ornamentation, towards the ventral margin, and the flat ribs are replaced by coarse striæ of growth, a feature which is unquestionably connected with the geratologic stage, while during the nealogic and ephebolic stages the shell is exactly like the Miocene specimens. We may, therefore, conclude that the living *Cytherea erycina* is the direct descendant of the Miocene species, but that in the geratologic stage it developed features which are unknown in the fossil representative.

CYTHEREA YOMAËNSIS, spec. nov., Pl. XII, figs. 13, 13*a*.

MEASUREMENTS.

Length.	Height.	L/H.
20·0 mm	18·7 mm.	1·07

The shell is obliquely triangular in size, very inequilateral, but height and length are only slightly different; the index L/H is therefore small; the shell is moderately and uniformly inflated. The umbo is pointed but depressed and so strongly prosogyric that it lies nearly in a line with the anterior margin. The pedal region is therefore very short, rounded, the siphonal one elongated and broadly accuminated; anterior, ventral and posterior margin form a broad curve the posterior end of which is abruptly turned in dorsal direction. The cardinal margin is long, angularly broken, its shorter anterior part passes gradually into the anterior margin, while the

longer posterior part is slightly convex, ventrally inclined and forms an obtuse angle with the posterior margin.

The lunula is large, slightly concave and hardly separated from the remainder of the surface, its boundary being marked by a finely engraved line.

The surface is shiny and apparently smooth; through a magnifying lens it is, however, seen that it was covered with numerous, exceedingly fine concentric striæ. A regular feature seems to be, however, the formation of some strong concentric marks of growth, which form strong varices, so to speak, particularly towards the ventral margin.

The hinge is not well exposed, but a right valve shows the ordinary development of Ca3p. Ligamental groove long.

Geological occurrence.—

Zone of *Pholas orientalis*, Thayetmyo.

Remarks.—Although the hinge is not sufficiently known it is quite certain that this species belongs to the genus *Cytherea*, s. str., to judge from the smooth surface.

In its *Nucula*-like shape it resembles so much to *Dione arrakanensis* that casts of the two species could hardly be separated, the only distinguishing feature would perhaps be the slightly broader siphonal region of *Cytherea yomaënsis*, as may be seen from comparison of the figures.

The chief distinguishing feature rests, however, in the different ornamentation of the surface, which except for the strong marks of growth is perfectly smooth in the species under description, while in *Dione arrakanensis* it is covered with strong rounded concentric ribs, separated by broad concave interstices.

Unfortunately the respective geological positions of the two specimens, with regard to each other, are not known; it may be quite possible that one is the descendant of the other, and it would be quite in harmony with the facts derived from the study of other species if we were to assume that the species with the coarser sculpture is the younger one.

There is no similarity with any of the other species, in fact its shape together with its smooth surface readily distinguish *Cytherea yomaënsis* from all the others.

Messrs. d'Archiac and Haime have described under the name of *Cyprina semilunaris* a species which appears to have a great similarity to *Cytherea yomaënsis*, at least as regards the general shape. This applies in particular to the young specimen, fig. 15, and if the lines of growth were a little stronger marked, the similarity of both species would be complete.

I refrain, however, from making any definite statement, because those of Messrs. d'Archiac and Haime's species, which have been based on casts like *Cyprina semilunaris*, are so ill-figured that it is impossible to form an opinion without the examination of the type specimen. It certainly may be questioned at once whether *Cyprina semilunaris* belongs to this genus or not, in fact I feel rather inclined to consider it as belonging to the genus *Cytherea*, and it may be quite possible that *Cyprina semilunaris* and *Cytherea yomaënsis* are identical, a question which must be left to the future to decide.

I have not been able to discover any living relative of this species which probably represents a type extinct among the fauna of the Indian Ocean.

3. Genus: DIONE, Gray.

The separation of the genus *Dione*, Gray, from *Cytherea*, Lam. (=*Meretrix*, Lam.) is not recognized by all authors, and it must be admitted that the palæontologist will always meet with considerable difficulties, unless the characters of the hinge are known. If only the outward characters of the shell are known, it is almost futile to attempt any distinction, but as most of the species here examined exhibit the characters of the hinge, which are different from that of the typical *Cytherea erycina*, I prefer to separate them under a different generic name.

Five species have been described which can be easily distinguished as follows:—

A. Surface covered with regular, rather strong concentric ribs.
- (a) Shell transversely oval.
  - 1. *Dione protolilacina*, spec. nov.
- (b) Shell triangular.
  - 2. *Dione arrakanensis*, spec. nov.

B. Surface covered with irregular concentric wrinkles.
- (a) Shell large, transversely oval.
  - 3. *Dione amygdaloides*, spec. nov.
- (b) Shell small, trigonal.
  - 4. *Dione dubiosa*, Noetling.

C. Surface covered with exceedingly fine, regular concentric ribs.
  - 5. *Dione protophilippinarum*, spec. nov.

No living relatives could be discovered of *Dione protolilacina*, *Dione arrakanensis*, *Dione amygdaloides* and *Dione dubiosa*, which unquestionably represent types extinct among the fauna of the Indian Ocean. On the other hand, it seems certain that *Dione protolilacina* represents a permanent nealogic stage of the living *Dione lilacina*, Reeve, from Australia, while *Dione protophilippinarum* is apparently the Miocene ancestor of the living *Dione philippinarum*, Reeve.

DIONE PROTOLILACINA, spec. nov., Pl. XII, figs. 14, 14a, Pl. XIII, fig. 1, a–c.

1881. *Cytherea lilacina*, Martin, Jungtertiär von Sumatra, p. 89, Pl. V, fig. 7.

Owing to the insufficiency of the material, no measurements could be taken, but it can safely be said that the shell is of moderate size, transversely elliptical in shape, the length exceeding the height considerably; the index L/H is, therefore, rather large. The umbo is low, prosogyric, situated slightly in front of the middle line; the anterior region is moderately long, slightly accuminated; the posterior one just a little longer, strongly accuminated.

The anterior, ventral and posterior margins form a broad elliptical curve,

which on either side forms a sharp pointed angle with the cardinal margin. The cardinal margin is long, angularly broken; the anterior part, which is the shorter, is slightly concave, the posterior one slightly convex. The lunula is ill-defined, rather long.

The ornamentation consists of numerous strong rounded concentric ribs separated by deep linear interstices. Hinge or internal characters not seen.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Meiocardia metavulgaris*, Singu.
Zone of *Arca theobaldi*, Kama.
Zone of *Parallelipipedum prototortuosum*, Kama.
Zone of *Pholas orientalis*, Thayetmyo.
Zone of *Cytherea erycina*, Prome.

Remarks.—The general shape of this species resembles closely to *Dione protophilippinarum*, that it might be mistaken for one of the varieties var. 1·17-1·36, that is to say, the more elongate ones. It will, however, at once be seen that it materially differs from that species by its more coarser ornamentation, that is to say, the ribs of *Dione protolilacina* are much stronger than those of *Dione protophilippinarum*, and in this regard it equals *Dione arrakanensis*, which is, however, easily distinguished by its *Nucula*-like shape. We might in fact describe the characters of this species in such a way as to say it is a *Dione protophilippinarum* bearing the ornamentation of *Dione arrakanensis*.

It is hardly doubtful that the specimens from Burma are identical with that species which has been described by Martin under the name of *Cytherea lilacina* from Sumatra, but it may perhaps be questioned, whether *Cytherea lilacina*, Martin, is identical with *Cytherea lilacina*, Lam. At any rate such a doubt cannot be suppressed, when Martin and Reeve's figures of this species are compared. Martin states, however, distinctly that " he is unable to discern one of his specimens from young individuals of *Cytherea lilacina*," an observation which gives a hint as to the relationship of the Tertiary and recent specimens.

It will, however, be useful to fix the differences between the Tertiary and living types; the latter attains a size which is not reached by any of the fossil ones, either from Burma or Sumatra; it is further distinguished by broader ribs, which, however, become effaced towards the ventral margin, but the sculpture of the umbonal region resembles closely to that of the Tertiary types.

From the above observation, that young specimens of the living *Cytherea lilacina* cannot be distinguished from the Tertiary types, we may therefore conclude that the latter is the direct ancestor of the living species, but that in the course of evolution the recent specimens have acquired characters which are not yet expressed in the fossil type. These characters are a larger, apparently thicker shell, broader ribs, which in the geratologic stage become effaced. The tendency of the evolution of more coarser features is, therefore, quite in harmony with the observations made in other species.

It seems, therefore, certain that, though *Dione protolilacina*, spec. nov., represents a type extinct among the fauna of the Indian Ocean, it is the direct ancestor of *Dione lilacina*, Reeve.

DIONE ARRAKANENSIS, spec. nov., Pl. XIII, fig. 2, *a-e*.

MEASUREMENTS

Length.	Height.	Thickness.	L/H.
21·4 mm.	18·4 mm.	6·8 mm.	1·17

The shell is obliquely triangular in shape, very inequilateral, the length exceeding the height only slightly, the index L/H is, therefore, rather small; it is moderately and uniformly inflated. The umbo is thick, inflated and so strongly prosogyric that it lies almost in a line with the anterior margin. Pedal region therefore very short, rounded, siphonal one elongated and accuminated. Anterior margin short rounded, passing gradually into the broadly rounded ventral margin, which in its turn passes gradually into the short posterior margin. Cardinal margin long, angularly broken; the anterior part being much shorter than the posterior one, passing gradually into the anterior margin; the posterior part is very long, slightly convex, strongly inclined in ventral direction, forming a pointed angle with the postero-ventral margin.

The lunula is large, slightly concave, devoid of any ornamentation, except lines of growth, well circumscribed by a sharply engraved line. The ornamentation consists of numerous, closely set, thin and sharp concentric ribs, which are separated by concave interstices of about double their breadth. Near to the ventral margin the strength of both is about such, that 3 ribs and 2 interstices come to 1 mm. in height.

The hinge is composed as follows:—

a. Right valve.

No right valve of this species being known, the hinge characters could be only conjectured from an impression of the hinge of the left valve; as this is insufficient for the finer study of details, particularly with regard to a comparison with other species, I refrain from any further conclusions, and I can only give the description in general outlines.

1. Anterior lateral teeth.

There are probably two rudimentary anterior laterals, LaI and LaIII, the latter being the smaller.

2. Cardinal teeth.

There is a thin lamellar anterior cardinal C3a, which was probably slightly opisthocline; C1 was probably similar in shape to the former, but slightly smaller; C3p is the largest, and strongly prosocline.

3. Posterior lateral teeth.

There were probably two posterior laterals, LpI and LpIII, both of which were certainly elongate, lamellar and very thin.

b. Left valve.

1. Anterior lateral teeth.

There is a transversely elongate, rather high, ventro-dorsally compressed anterior lateral tooth LaII which is strongly opisthocline, and almost horizontal, having a deep socket on its dorsal side.

2. Cardinal teeth.

The anterior cardinal tooth C2a is thin, lamellar, slightly curved and opisthocline, having a deep socket on its anterior and posterior side; at the apex it is joined to C2p. This tooth is broad at its base, attenuated at its apex, strongly prosocline and joined to C2a, forming an unsymmetrical Λ shaped tooth, the apex of which is strongly drawn in anterior direction; behind it is a deep, broad socket, which is followed by an elongate, curved and strongly prosocline tooth C4p, which is almost amalgamated to the ligamental nymphe.

3. Posterior lateral teeth.

There is only a rudimentary elongate curved posterior lateral LaII.

The hinge formula is, therefore, as follows :—

Right valve	La. (III) : I	C. 3a : 1 : 3p	Lp. (III) : I.
Left valve	La. II :	C. : 2a : 2p : 4p	Lp. (II).

Geological occurrence.—

Zone of ***Parallelipipedum prototortuosum***, Kama.

Remarks.—The oblique, triangular *Nucula*-like shape, together with the nearly terminal umbo, distinguish this species which is apparently pretty rare from all the others.

No living relative of this species could be found, and it most probably represents a type extinct among the fauna of the Indian Ocean.

DIONE AMYGDALOIDES, spec. nov., Pl. XIII, figs. 3, *a-b*, 4, *a-c*.

MEASUREMENTS.

(a) Right valve.				(b) Left valve.			
	Length.	Height.	L/H.		Length.	Height.	L/H.
(1)	38·2 mm	?	?	(1)	36·2 mm.	27·4 mm.	1·32
				(2)	30·5 „	25·2 „	1·21

The shell is of tolerably large size, transversely oval, though the length does not exceed the height very much, the index L/H is therefore small; it is moderately inflated, rather inequilateral; the umbo is gibbous but somewhat depressed and strongly prosogyric, being situated in the anterior third of the length. The pedal region is short, rounded, the siphonal one elongated and broadly acuminated. The anterior margin is rather long and passes in a broad curve into the more or less curved, ventral margin, which in its turn passes gradually into the broadly rounded posterior margin; the cardinal margin is broadly curved, the posterior part which

is longer than the anterior one, forming a rounded off angle with the posterior margin, while the shorter anterior one passes gradually into the anterior margin.

The ornamentation consists of numerous concentric, more or less deeply engraved, somewhat irregular striæ; on the anterior region these striæ are much deeper and more closely set than on the posterior region; this results in the production of some irregular, flat ribs on the anterior region, which become, however, very soon effaced.

The hinge is composed as follows:—

a. Right valve.

As only the left valve is known, the hinge of the right valve had to be constructed from a cast of that of the left one, its composition can, therefore, only be ascertained in a sort of general way.

1. Anterior lateral teeth.

There are apparently two anterior laterals LaI and III, both of which are probably small, LaIII almost rudimentary.

2. Cardinal teeth.

The anterior cardinal C3a was probably lamellar, thin, and slightly prosocline, having a slit-like socket on its posterior (ventral) side; C1 was similar in shape to the former, almost parallel to it, and therefore slightly prosocline; behind it is a deep socket, and then follows a large strongly prosocline C3p, of which it is impossible to say whether it was bifid or not; in all probability this was, however, the case.

3. Posterior lateral teeth.

It is very probable that there existed two elongate, but rudimentary posterior laterals LpI and LpIII.

b. Left valve.

1. Anterior lateral teeth.

There is a strong ventro-dorsally compressed, transversely-elongate, anterior lateral LaII which is so strongly opisthocline that it lies almost horizontal; on its dorsal side is a deep socket.

2. Cardinal teeth.

The anterior cardinal tooth C2a is very thin, lamellar, strongly prosocline, with a deep socket at either side; its apex is joined to C2p; this tooth is very strong and broad at the base, attenuated towards the apex, strongly prosocline, forming with C2a a Λ shaped unsymmetrical tooth, the apex of which is strongly drawn in anterior direction. Behind it is a deep broad socket, and then follows the lamellar, elongate and strongly curved and prosocline C4p, which is almost amalgamated to the ligamental nymphe.

3. Posterior lateral teeth.

There is a rudimentary elongate, curved and prosocline posterior lateral LaII, having a shallow socket on its ventral side.

The hinge formula is, therefore, as follows :—

Right valve	La. (III) :	I	C.	3a :	1 :	3p :		Lp. (III) :	(I).
Left valve	La.	II :	C. :	2a :	2p :	4p		Lp.	(II)

Ligamental groove long. Pallial impression and muscular scars not seen. Lunula large, but ill-defined by a very indistinct line, ornamented with concentric striæ only.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Paracyathus caeruleus*, Yenangyat.
Zone of *Arca theobaldi*, Kama.
Zone of *Parallelipipedum prototortuosum*, Kama.
Zone of *Pholas orientalis*, Thayetmyo.
Zone of *Aricia humerosa*, Thayetmyo.

Remarks.—I have hesitated for a long time whether this species should not be considered as a variety of *Cytherea erycina* only; after a careful examination I think, however, that its features are such as to justify a specific separation. Except *Cytherea erycina*, it is larger than any other species; a broadly rounded, only slightly accuminated posterior side, as well as a rather irregular ornamentation, readily distinguish it from all the others.

The type of *Dione amygdaloides* seems to be extinct among the fauna of the Indian Ocean.

DIONE DUBIOSA,[1] Noetling, Pl. XIII, fig. 11, *a-e*.

1895. *Astarte* (?) *dubis*, Noetling, Mar. Foss. from Mioc. of Upper Burma, Mem. Geolog. Survey of India, Vol. XXVII, Pt. 1, Pl. I, figs. 8-8a.

MEASUREMENTS.

Length.	Height.	Thickness.	L/H.
22·7 mm.	21·6 mm.	14·0 mm.	1·05

Although this species is pretty common, it is rarely that it is so well preserved that reliable measurements can be taken; only one specimen which had both valves united allowed of correct measuring, but to judge from the other specimens the size of the shell did not greatly exceed the above length of 22·7 mm.

The shell is triangular in shape, and as the height nearly equals the length the index L/H is very small; it is not very inequilateral, and slightly inflated. The umbo is pointed, gibbous and strongly prosogyric, situated slightly in front of the middle line. The pedal region is short, somewhat produced, rounded; the siphonal region is broadly accuminated, and perhaps a little shorter than the anterior one.

[1] By a misprint this name has been spelled "dubia" in my former memoir.

The anterior margin forms with the ventral margin a broad curve, which in its turn forms a rounded off angle with the short posterior margin. The cardinal margin is angularly broken, both parts being nearly of the same length; the posterior part, which is slightly convex and strongly inclined in ventral direction, passes gradually into the posterior margin, while the straight anterior part, which is equally strongly inclined in ventral direction, passes gradually into the anterior margin.

The lunula is large, but very ill-defined by a fine, hardly perceptible line; except some strong striæ of growth it is devoid of any ornamentation.

The ornamentation consists of numerous concentric, somewhat irregular ribs, separated by deep interstices of the same breadth as the ribs; their strength is about such, that there are 2 ribs and 1 interstice to 1 mm. in height near the ventral margin. At the umbonal region the ribs are fine and regular, but they become very soon somewhat irregular, inasmuch as towards their posterior end they bifurcate into two thin branches, between which sometimes another thin rib is intercalated; this feature increases with the size of the shell in such a way that the point of bifurcation moves anteriorly; the postero-ventral portion is therefore covered with numerous fine, very closely set, though somewhat irregular concentric ribs, while anteriorly the original ribs are still well marked, though interspersed with finer ones; on reaching the lunula all ribs suddenly terminate. Internal features or hinge not observed.

Geological occurrence.—

Zone of *Paracyathus caeruleus*, Yenangyat.
Zone of *Dione dubiosa*, Yenangyat.

Remarks.—The species is very common at Yenangyat where it covers the layers of a hard quartzitic sandstone, the "signal hill standstone" which forms here a conspicuous bed in the sequence of the strata. The specimens are, however, mostly broken and in fragments, complete specimens being rare.

I originally described this species as *Astarte* (?) *dubiosa* from Yenangyat, but as the examination of the hinge of related species has proved that my view of the generic position of this species was wrong, I hasten to rectify it.

Dione dubiosa is easily distinguished by its triangular shape, the pointed umbos and its coarse, irregular ornamentation; in the latter regard it resembles somewhat to *Dione arrakanensis*, but this species is easily distinguished by its obliquely triangular shape, the umbos being strongly produced anteriorly, while they are median in *Dione dubiosa*; *Dione protolilacina* is easily distinguished by its more elongate shape and by its finer sculpture.

Dione protophilippinarum has a more orbicular shape and a much finer and more elongate regular ornamentation.

No living relative of this species could be discovered, and it probably represents a type which is extinct at present among the fauna of the Indian Ocean.

DIONE PROTOPHILIPPINARUM, spec. nov., Pl. XIII, figs. 5, *a-d*, 6, *a-d*, 7, *a-d*, 8, *a-b*, 9, *a-b*, 10.

MEASUREMENTS.

	Length.	Height.	L/H.		Length.	Height.	L/H.
(*a*) Complete shell.				(*c*.) Left valve.			
(1)	22·1 mm.	19·9 mm.	1·11	(14)	13·8 mm.	12·4 mm.	1·11
(*b*) Right valve.				(15)	23·0 „	19·1 „	1·20
(2)	23·9 „	19·5 „	1·22	(16)	21·3 „	17·7 „	1·20
(3)	23·8 „	18·0 „	1·32	(17)	21·3 „	16·7 „	1·27
(4)	22·8 „	18·4 „	1·24	(18)	20·4 „	18·0 „	1·13
(5)	20·8 „	15·3 „	1·36	(19)	16·0 „	13·7 „	1·16
(6)	19·0 „	15·5 „	1·22	(20)	15·0 „	13·2 „	1·13
(7)	19·0 „	15·1 „	1·25	(21)	14·7 „	12·9 „	1·13
(8)	18·3 „	15·3 „	1·20	(22)	14·1 „	13·3 „	1·06
(9)	17·5 „	15·1 „	1·16	(23)	13·9 „	12·6 „	1·10
(10)	17·1 „	14·5 „	1·17	(24)	10·0 „	8·9 „	1·12
(11)	16·8 „	14·2 „	1·18	(25)	8·7 „	7·2 „	1·20
(12)	14·9 „	11·0 „	1·35				
(13)	14·0 „	12·0 „	1·17				

The shell does not attain a large size, but it is very variable in shape, changing from nearly obicular specimens, having as small an index as 1·06 to transversely elongate or oval specimens with an index of 1·36. If these two extremes are considered alone, it is hardly conceivable that specimens so widely different in shape should belong to one and the same species. If, however, the two varieties, those of a low and those of a high index, are separated, it will be seen that in both groups there are specimens from which it is difficult to say to which group they should be referred to, as they are in fact intermediate between both.

Though the small number of specimens, 25 altogether, which could be measured with accuracy seem hardly sufficient for the study of variation, it will be well to have them arranged according to the index L/H. This will give the following table :—

Index . . .	1·06	1·07	1·08	1·09	1·10	1·11	1·12	1·13	1·14	1·15	1·16	1·17	1·18	1·19	1·20
Number of specimens .	1	...	...	...	1	2	1	3	...	1	2	2	1	...	4
Index . . .	1·21	1·22	1·23	1·24	1·25	1·26	1·27	1·28	1·29	1·30	1·31	1·32	1·33	1·34	1·35
Number of specimens .	1	2	...	1	1	...	1	...	...	...	...	1	...	...	1
Index . . .	...	1·36	...	...	...	...	...	...	...	...	...	...	...	...	...
Number of specimens .	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...

In the above table the chain is nearly uninterrupted between the indices 1·10 and 1·27, but I hardly doubt that the remaining gaps will be filled up if more material comes to be examined. From the above figures we may conclude that the amplitude of variation is rather a large one; the formula should, therefore, be written as follows :—

$$\text{var. } 31. \left|\begin{array}{l} 1{\cdot}36 \\ \\ 1{\cdot}06 \end{array}\right.$$

The above figures exhibit a characteristic feature. If we consider for a moment all the specimens having an index 1·06 to 1·18, that is to say, all the more

orbicular varieties, we find that the mathematical average is 1·12, the calculated one 1·13; around these two indices, that is to say, between 1·10 and 1·13, are 7 or 50% of the number to be found; but if we take the total of all specimens we find that the average index is 1·21; again we notice that 6 specimens or more than 25% of the total are gathered around the indices 1·20 to 1·22, while exactly the same number is gathered between indices 1·11 and 1·13.

If from the scanty material any conclusions may be drawn they would show that the curve of variation shows two bulgings, one at 1·13 and another at 1·20. The latter being nearly the average of the total number proves the rule that far the greatest number of specimens show the average index L/H, and that therefore notwithstanding the wide difference in shape between var. 1·06 and var. 1·36 it is impossible to keep them separate. On the other hand it is quite obvious that the orbicular varieties show the tendency of developing a large number of var. 1·11 to 1·13 which might eventually lead to the evolution of a new species.

It will be well to describe two typical specimons of both varieties separately with regard to their shape.

a. Var. orbicularis, var. 14 $\begin{smallmatrix}1\cdot19\\ |\\ 1\cdot06\end{smallmatrix}$;

a specimen which has the index 1·11, is almost circular in shape, and rather strongly inflated; the umbo is tumid, but low, strongly curved anteriorly, and situated in front of the middle line; the pedal region is short, rounded, the siphonal one about the same length, indistinctly truncated. The anterior part of the cardinal margin, the anterior margin and the ventral margin form a broad curve, which passes gradually into the short, slightly convex posterior margin; the latter forms with the long posterior part of the cardinal margin an obtuse angle.

b. Var. elongata, var. 17 $\begin{smallmatrix}1\cdot36\\ |\\ 1\cdot20\end{smallmatrix}$;

a specimen which has an index of 1·24, is triangularly oval in shape, strongly inflated; the umbo is tumid, but low and strongly curved forwards, situated rather in front of the middle line; the pedal region is short, rounded, the siphonal one elongated and slightly accuminated. The anterior part of the cardinal margin passes gradually into the broadly rounded anterior margin, which in its turn gradually passes into the slightly curved ventral margin. The posterior margin is short, and forms an obtuse angle with the long ventrally inclined posterior portion of the cardinal margin. Cardinal margin long, strongly curved.

The lunula is large, not concave, and well defined by a deeply engraved sharp line.

The ornamentation consists of numerous very fine concentric ribs, which are separated by linear, sharp interstices; there are about 3 ribs and 4 interstices to 1 mm. in height near the ventral margin; some of the ribs die out in anterior and posterior direction, without reaching the margin; there is, however, apparently no rule in this regard.

The hinge is composed as follows :—

a. Right valve.

1. Anterior lateral teeth.

The anterior laterals are very reduced in size; they are on either side of a deep, tranversely elongate socket; the ventral one, LaI, being the larger, the dorsal one, LaIII, much smaller and close to the anterior margin.

2. Cardinal teeth.

The anterior cardinal tooth C3a is thin, lamellar, rather longer than C1 and slightly prosocline; it is separated by a thin slit-like socket on its posterio-(ventral) side from a smaller, thin lamellar C1, which is just perceptibly prosocline; on its dorsal side is a broad and deep socket behind which there is a strong posterior cardinal C3p; it is broad at its base, attenuated towards the apex, strongly prosocline, the apex just touching C2a, and deeply bifid; a deep furrow separates it from the strong ligamental nymphe.

3. Posterior lateral teeth.

There are two thin elongate prosocline posterior laterals LpI and LpIII separated by a long slit-like socket.

b. Left valve.

1. Anterior lateral teeth.

There is only one anterior lateral LaII, which is slightly opisthocline and almost horizontal; it is strong, high, transversely elongate, having a deep socket on its dorsal side.

2. Cardinal teeth.

The anterior cardinal C2a is thin, lamellar and slightly prosocline, having on either side a deep socket; its apex is joined to C2p, which is broad at the base, attenuated towards the apex, and so strongly prosocline that it lies almost horizontally; together with C2a it forms an unsymmetrical shaped tooth, the apex of which is slightly anteriorly produced. On the dorsal side of C2p is a deep, broad socket and behind it, almost entirely amalgamated to the ligamental nymphe, an elongate lamellar tooth C4p, which is curved and strongly prosocline.

3. Posterior lateral teeth.

There is only a rudimentary elongate posterior lateral La II having a shallow socket on its ventral side.

The hinge formula is, therefore, as follows:

Right valve La.	(III) : I	C. 3a : 1 : 3p :	Lp. (III) : (I).
Left valve La.	: II	C. : 2a : 2p : 4p	Lp. (II) :

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Meiocardia metavulgaris*, Singu.
Zone of *Cancellaria martiniana*, Minbu.
Zone of *Paracyathus caeruleus*, Yenangyat.
Zone of *Arca theobaldi*, Kama.
Zone of *Parallelipipedum prototortuosum*, Kama.
Zone of *Pholas orientalis*, Thayetmyo.
Zone of *Aricia humerosa*, Thayetmyo.
Zone of *Cytherea erycina*, Prome.

Remarks.—Notwithstanding its variable shape, this species is easily distinguished from all the others by its fine, thread-like ribs, which never attain the coarseness of those of any other species.

Dione protophilippinarum is one of the most common species in the Miocene of Burma; it ranges from the deepest strata to almost the top of the series, and specimens from the zone of *Parallelipipedum prototortuosum* are undistinguishable from those of the zone of *Meiocardia metavulgaris*.

Among the living species, *Dione philippinarum*, Hanl., from the Andamans seems its nearest relative; the living specimen I have under examination has an index of 1·16, and it resembles in shape exactly to fossil specimens of the same index; the only difference consists in the stronger ribs of the *Dione philippinarum*, but this feature would be quite in consistence with the similar feature noticed in other specimens. It seems to me therefore unquestionable that this species is the direct descendant of *Dione protophilippinarum*.

4. Genus: TAPES, Megerle.

TAPES PROTOLIRATA, spec. nov., Pl. XIII, figs. 12, 12*a*, 13, 13*a*.

MEASUREMENTS.

	Length.	Height.	L/H.
(*a*) Right valve	34·5 mm.	19·5 mm.	1·77
(*b*) Left valve	33·5 „	17·5 „	1·91

The shell is transversely elongate, elliptical, the length exceeding the height considerably, the index L/H being therefore high; it is inequilateral, and moderately inflated. The umbo is low, depressed slightly in front of the middle, prosogyric. The pedal region is elongate, a little accuminated; the siphonal region longer than the anterior one, produced and accuminated. The anterior margin is rounded rather long; the ventral margin is nearly straight, strongly turned in dorsal direction at its anterior end; the posterior margin is short, convex, forming an obtuse angle with both ventral and cardinal margin. The cardinal margin is very long, angularly broken; the anterior portion is the shorter, and slightly concave; the posterior is long, straight, and strongly inclined in ventral direction.

An obtuse, indistinct keel runs from the umbo towards the posterior corner, behind which the surface is strongly inclined. The lunula is apparently long, but narrow and ill-defined.

The ornamentation consists of numerous, strong concentric ribs, separated by deep furrow-like interstices. The ribs are very regular, flatly rounded, and cover the whole surface uniformly, taking a sharp dorsal turn after crossing the posterior keel. The interstices are slightly narrower than the ribs, deeply concave.

Geological occurrence.—

Horizon unknown, Miocene, Thayetmyo,

Remarks.—Its high index, that is to say, its very elongate shape together with the strong concentric ribs readily distinguish this species.

Only two casts have come under examination, and their generic position might perhaps be questioned, inasmuch as nothing is known about the hinge, and as an ornamentation, as described, occurs in various genera. I have, however, judging from the similarity this species bears to some species belonging to *Tapes*, referred it to this genus.

From comparison with *Tapes lirata*, Phil. spec., which inhabits the Indian Ocean and the Eastern Seas, I think that this species is the nearest relative to the Miocene specimens, and having a larger size and coarser ribs, this feature would be quite in concordance with the observation made in other species.

Genus: DOSINIA, Scopoli.

Dosinia protojuvenilis, spec. nov., Pl. XIV, figs. 1, 1*a*, 2, *a-d*.

Measurements.

(*a*) Right valve.	Length.	Height.	Thickness.	L/H.	(*b*) Left valve.	Length.	Height.	Thickness.	L/H.
(1)	$25\cdot_{3}$ (?) mm.	$23\cdot_{4}$ mm.	? mm.	1·08	(1)	$17\cdot_{7}$ mm.	$16\cdot_{5}$ mm.	?	1·05
(2)	$20\cdot_{1}$,,	$19\cdot_{1}$,,	$5\cdot_{7}$,,	1·06	(2)	$17\cdot_{6}$,,	$16\cdot_{6}$,,	?	1·08
(3)	$17\cdot_{3}$,,	$16\cdot_{9}$,,	$4\cdot_{6}$,,	1·03	(3)	$12\cdot_{4}$,,	$11\cdot_{1}$,,	?	1·07
(4)	$9\cdot_{7}$,,	$9\cdot_{7}$,,	$3\cdot_{1}$,,	1·00	(4)	$23\cdot_{6}$,,	$20\cdot_{4}$,,	?	1·12

The shell is of orbicular shape, length and height being nearly the same; the index L/H is therefore very small, 1·04 in the average; it is nearly equilateral and rather flat. The umbo is pointed, strongly prosogyric and situated in front of the middle line. The pedal region is short, but broadly rounded, the siphonal one short, broadly accuminated. Anterior, ventral and posterior margin form nearly a complete circle; the cardinal margin is angularly broken; the shorter anterior part, which is slightly concave, forms a very obtuse angle with the anterior margin; the longer, slightly convex posterior part forms a sharp obtuse angle with the posterior margin.

The lunula is very small, concave, and well defined by a sharp deeply engraved line.

The ornamentation consists of numerous narrow, flat, concentric ribs which are separated by deeply engraved linear interstices, there being about five ribs and six interstices to 1mm. height near the ventral margin. On the anterior and posterior region some of the ribs become obsolete and die out, while the remaining ones are raised into sharp lamellæ, separated by broad interstices.

The hinge is composed as follows:—

a. Right valve.

1. Anterior lateral teeth.

Both anterior laterals LaI and LaIII are of the same size, very rudimentary, granular, strongly opisthocline and separated by a short shallow socket.

2. Cardinal teeth.

The anterior cardinal tooth C3a is close to the anterior margin, thin, lamellar and strongly opisthocline; it is separated by a narrow slit-like socket from C1; this tooth is similar in shape to C3a, but a little smaller and almost parallel to it; on its posterior side is a deep socket which is followed by a strong elongate, bifid tooth, curved and prosocline; behind it is a narrow furrow, separating it from the ligamental nymphe.

3. Posterior lateral teeth.

There are two thin lamellar posterior laterals LpI and LpIII, separated by rather a deep socket; both are rather long, and strongly prosocline.

b. Left valve.

No left valve is known, but from an impression of the hinge of the right valve its general composition can be judged with great accuracy.

1. Anterior lateral teeth.

There is only one lateral tooth LaII close to the anterior margin; most probably it was very small, but still stronger than the teeth of the right valve, compressed in dorso-ventral direction, and opisthocline.

2. Cardinal teeth.

The anterior cardinal tooth C2a must have been very thin, lamellar, and opisthocline, having a deep socket on either side; it is very probable that it was joined with its apex to C2p; this tooth was apparently rather strong, broad at the base, attenuated towards the apex, and strongly prosocline, forming most probably a Λ-shaped unsymmetrical tooth with C2a, the apex of which was not anteriorly drawn; on the dorsal side of C2p was a deep socket, and behind probably a thin, elongate and lamellar C4p, which was curved and strongly prosocline, rudimentary and almost amalgamated to the ligamental nymphe.

3. Posterior lateral teeth.

There was probably only a single posterior lateral LpII of thin elongate shape, curved and strongly prosocline.

The hinge formula is therefore—

Right valve	La. (III) : I	C. 3a : 1 : 3p :	Lp. (III) : (I).
Left valve	La. II	C. : 2a : 2p : (4p)	Lp. (II).

The ligamental groove is long and deep. Muscular impressions small, ill-defined; pallial sinus apparently very shallow.

Test thin, measuring 0·95 mm. and under in thickness.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.
Zone of *Aricia humerosa*, Thayetmyo.
Zone of *Cytherea erycina*, Prome.

Remarks.—In its shape *Dosinia protojuvenilis* resembles somewhat to *Dione dubiosa*, but a comparison of both species shows that, in the first species, the ventro-posterior margin curves much more in dorsal direction than in the latter; in *Dione dubiosa* the posterior part of the cardinal margin is therefore much longer, and

reaches further down than in *Dosinia protojuvenilis*. The umbo of this species is also much more anteriorly curved than in *Dione dubiosa*, but the chief distinguishing feature is the difference of the ornamentation. In *Dione dubiosa* there are strong rounded concentric ribs, separated by broad interstices, in *Dosinia protojuvenilis* we have fine flat ribs, separated by linear interstices, and raised into sharp lamellæ at the anterior and posterior end, a feature which is not developed in any other species, thus forming a good character, by which it may be discerned from the others.

There are two living species, *Dosinia juvenilis* and *Dosinia laminata*, both living at the Philippine Islands, which can be compared to the Miocene species; in fact it seems to me very difficult to give a definite opinion which of these two is closer related to the fossil one, without having specimens for comparison. To judge from the description *Dosinia juvenilis* seems to attain a larger size and has a more massive shell than the Miocene species; this feature would be quite in harmony with the observations made in other species; on the other hand, *Dosinia laminata* bears such a strong resemblance with regard to the shape of the shell and the characters of the ornamentation that it is difficult to express the notion that it is the closest relative to the Miocene species.

I think it therefore better to describe it under a new name, remembering always that *Dosinia juvenilis* is, if not identical, most probably its direct descendant.

Dosinia protojuvenilis apparently represents a type which is extinct among the present fauna of the Indian Ocean.

Family: *TELLINIDÆ*, Stoliczka.

1. Genus: TELLINA, Linné.

The genus *Tellina* comprises such a large number of widely different species that its subdivision has been a long felt necessity. The various sub-genera adopted by zoologists may be very useful when dealing with the living species, but when it comes to fossil ones, one is generally at a loss how to apply those names. Even if the hinge is well preserved, I think its smallness is a great drawback against the exhibition of distinguishing features. It would certainly be very useful if a critical study of the hinges of living and Tertiary *Tellinidæ* would come forward.

On the following pages seven species belonging to this genus have been described, but it is unquestionable that there are at least two more species as is indicated by fragments which are too ill-preserved to be described, but which could not be included in any of the determinated species.

These seven species represent at least five sub-genera; so widely do they differ from each other with regard to the characters of the shell. They can be easily distinguished as follows:—

A. Shell inequilateral.

(*a*) Shell inequivalve.

(*aa*) Very inequivalve, contorted with a strong fold on the siphonal region.

1. *Tellina* (*Metis*) *grimesi*, spec. nov.

(*bb*) Slightly inequivalve, without a posterior fold, shell orbicular.

2. *Tellina protostriatula*, spec. nov.

(*b*) Shell equivalve.

(*aa*) Shell transversely oval, index L/H high.

3. *Tellina protocandida*, spec. nov.

(*bb*) Shell triangular.

4. *Tellina indifferens*, spec. nov.

B. Shell slightly inequilateral.

(*a*) Surface almost smooth, slightly striated.

5. *Tellina* (*Phylloda*) *foliacea*, Reeve.

(*b*) Surface covered with sharp concentric ribs.

(*aa*) Ribs raised and sharp at their extremities only, flat in the middle.

6. *Tellina* (*Tellinella*) *hilli*, Noetling.

(*bb*) Ribs raised and sharp throughout.

7. *Tellina* (*Tellinella*) *pseudohilli*, spec. nov.

Out of these seven species only one, ***Tellina foliacea***, Reeve, is identical with the species of the same name inhabiting the Indian Ocean; all the others represent extinct types. One of them, ***Tellina grimesi***, has apparently no living relative, but seems to have a great similarity with ***Tellina sinuata***, Lam., from the Paris Eocene. The remaining five species, ***Tellina protostriatula***, ***Tellina protocandida***, ***Tellina indifferens***, ***Tellina hilli***, ***Tellina pseudohilli***, are closely related to species inhabiting at present the Eastern Seas.

TELLINA (METIS) GRIMESI,[1] spec. nov., Pl. XIV, figs. 4, *a*-*c*, 5, *a*-*b*, 6, *a*-*b*.

MEASUREMENTS.

(*a*) Right valve.

	Length.	Height.	L/H.
(1)	39·2 mm.	?	?
(2)	38·4 „	37·6	1·03

(*b*) Left valve.

	Length.	Height.	L/H.
(1)	30·8 mm.	25·0 mm.	1·23

The shell is inequivalve, irregularly triangular in shape, very inequilateral although height and length do not much differ; moderately inflated. The umbo is pointed, strongly depressed, and prosogyric. Pedal region broad, rounded; siphonal region somewhat contracted, truncated. The anterior part of the cardinal margin is straight and passes gradually into the broadly rounded anterior margin, which in its turn passes gradually into the oblique ventral margin; the posterior margin is oblique, deeply sinuated and passes gradually into the posterior part of the cardinal margin, while it forms a rounded corner with the ventral margin. Cardinal margin of the right valve strongly curved. A broad, somewhat flattened fold runs from the umbo towards the posterior corner, in front of which there is a broad, but shallow depression, while a narrow and deep one accompanies it on the posterior side. On

[1] I dedicate this species to my late lamented colleague Mr. Grimes, who found such an untimely death from cholera at Thayetmyo, just when going to re-examine the Kama shales.

the left valve the reverse takes place, that is to say, a broad and deep depression runs from the umbo towards the posterior corner, which is accompanied on either side by a strong keel. A gaping of the valves is thus effectually prevented. There is no lunula, but the anterior region is slightly concave towards the umbo. There is no ornamentation, except numerous fine, concentric striæ of growth, which are very closely set and of which finer and coarser ones alternate irregularly.

In the right valve there are two small, rudimentary cardinal teeth just below the umbo, separated by a small socket; immediatly behind the posterior tooth follows the partly internal, ligamental groove; there are also two rudimentary posterior laterals with a shallow socket between. The interpretation of the hinge is not easy, the posterior laterals in the right valve are unquestionably LpI and III, the two cardinal might be considered as C3a and C3p; this would correspond to C2a in the left valve; the hinge formula would therefore be—

Right valve	La. O.	C. 3a : 1	Lp. I : III.
Left valve	La. O.	C. 2a	Lp. II.

Muscular scars very indistinct, but the anterior very long; pallial impression all marked.

Test very delicate, varying from 0·58 to 0·75 mm. in thickness; owing to this thin test, concentric irregular wrinkles and folds marking different stages of growth are always well marked on casts.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Meiocardia metavulgaris*, Singu.
Zone of *Arca theobaldi*, Kama.
Zone of *Parallelipipedum prototortuosum*, Kama.
Zone of *Pholas orientalis*, Thayetmyo.
Zone of *Aricia humerosa*, Thayetmyo.
Zone of *Cytherea erycina*, Prome.

Remarks.—This species is easily recognizable by the irregular, curiously distorted shape and the broad folds on the posterior region; both features are so characteristic, that even fragments are easily recognized.

No similar species has hitherto been described either from India or Java, but from Nias,[1] Bœttger has described under the name of *Tellina* (*Metis*) *niasensis*, a species the general shape of which marks it a relative of *Tellina* (*Metis*) *grimesi*. The Sumatran species are, however, very ill-preserved, and I would hesitate to express such a definite opinion with regard to generic position and relatives as Bœttger does, because he has noticed neither the hinge nor the pallial impression; it seems to me that under these circumstances the position attributed to these rather fragmentary specimens is not so absolutely certain.

With regard to the Burma specimens I am in fact nearly in the same doubt as to the generic position; although the specimens are so well preserved, certain important features could not be observed with the desirable correctness; none of

[1] Tertiärformation von Sumatra, page 116.

the specimens under examination show the pallial impression well marked; if I correctly interpret the traces left by one of the casts from the zone of *Meiocardia metavulgaris*, the pallial line was deeply sinuated, but it is quite possible that these marks are only an accidental combination of some cracks in the shell, as none of the others, amongst which there is a fine cast from Yenangyat, exhibit this feature. The character of the hinge indicates the genus *Tellina*, and although the question of a sinuated or entire pallial line must remain in abeyance, the other features are in favour of the supposed generic position.

I may, however, mention that there are certain species belonging to the genus *Lucina* like *L. sinuosa*, Dun., and others which have a somewhat similar shell; as the characters of the hinge would not entirely be against such an assumption, this species should rank among the *Lucinæ* if its pallial impression should be found to be entire and not sinuated.

Tellina (*Metis*) *grimesi* represents unquestionably a type extinct among the fauna of the Indian Ocean, as I have not been able to discover any similar species. On the other hand *Tellina sinuata*, Lam., from the Eocene of Paris seems a very close relative.

TELLINA PROTOSTRIATULA, spec. nov., Pl. XV, figs. 1, *a-b*, 2, *a-f*.

MEASUREMENTS.

	Length.	Height.	L/H.
(1)	32·5 mm.	28·0 mm.	1·16
(2)	22·9 „	19·7 „	1·16
(3)	17·0 „	13·3 „	1·27

The shell is slightly inequivalve, nearly orbicular in shape, the length being still slightly in excess of the height, index L/H small; it is very flat and subequilateral. The umbo is low, pointed, situated behind the middle line.

The pedal region is broadly rounded, the siphonal one considerably shorter, accuminated. The anterior margin is rounded and passes gradually into the strongly convex, ventral margin which at its posterior end is turned in dorsal direction, forming a sharp angle with the posterior margin. The cardinal margin is long, angularly broken; the straight anterior portion which is the longer, is ventrally inclined and passes gradually into the anterior margin; the shorter posterior portion which is also ventrally inclined, forms so obtuse an angle with the slightly convex posterior margin, that both appear fully to be merged into each other.

An obtuse, but still well marked keel runs from the umbo towards the posterior corner, the surface dropping slightly behind it.

The surface appears to be perfectly smooth; there are only numerous, very fine concentric striæ of growth, which are crossed by exceedingly fine radiating striæ which are, however, only visible through a magnifying lens and under favourable conditions of preservation.

Seen from above the shell appears to be slightly twisted; on the anterior side the cardinal margin of the left valve is slightly bent in an ~like manner overlapping to the right; on the posterior side both valves are slightly bent to the right.

Geological occurrence.—

Zone of ***Parallelipipedum prototortuosum***, Kama.

Zone of ***Arca theobaldi***, Kama.

Remarks.—This species is easily distinguished by its flat, orbicular shell having a siphonal region which is shorter than the pedal one, and by the smoothness of the surface exhibiting only very delicate radial and concentric striæ.

Professor Martin has described several species from Java, which seem to have a close similarity to the species here described; unfortunately the figures are not very distinct ones, and I am unable to say which of both, *Tellina* (*Argopagia*) *dijki* or *Tellina rotunda*, is the nearer relative.

Among the living species, *Tellina striatula*, Lam., which inhabits the sea of the Philippine Islands, agrees so well with regard to shape and ornamentation that I feel inclined to consider it as identical with the Miocene species. As, however, *Tellina striatula* appears to attain a larger size, and as its ornamentation is a coarser one, I preferred to distinguish the Miocene species by a new name, keeping in mind that it was most probably the ancestor of the living one.

It is very probable that *Tellina protostriatula* represents a type extinct among the present fauna of the Indian Ocean.

TELLINA PROTOCANDIDA, spec. nov., Pl. XV., figs. 4, *a-b*, 5, *a-b*.

MEASUREMENTS.

	Length.	Height.	L/H.
Left valve	38·5 mm.	23·0 mm.	1·67

Only a single left valve, and two fragments of the umbonal part of a left and right valve have come under examination.

The shell is transversely oval, a little triangular in shape, the length being greatly in excess of the height, and the index therefore comparatively high, it is rather flat and very inequilateral. The umbo is low, depressed, situated behind the middle line.

The pedal region is very elongate, slightly accuminated; the siphonal region much shorter, accuminated and truncated.

The anterior margin is short, rounded, passing gradually into the long straight ventral margin; the posterior margin is short, almost straight, forming an obtuse angle with both ventral and cardinal margin. The cardinal margin is angularly broken, both portions forming a very obtuse angle; the longer anterior portion is straight, slightly ventrally inclined, passing gradually into the anterior margin; the posterior portion, which is a little shorter, is strongly ventrally inclined, forming an obtuse angle, the corner of which is rounded off, with the posterior margin.

The ornamentation consists of numerous, fine, deeply engraved concentric lines,

separating narrow flat strips, or bands, which, though being homologous to ribs, could not well be described under this term.

In the right valve there is a strong though short bifid tooth underneath the umbo representing C1, having on either side a deep triangular socket; on the dorsal side of the anterior socket there is a small oblique tooth C3a; the laterals are apparently rudimentary; LaI is elongate, having a deep long socket on its dorsal side; LpI not observed but apparently present.

In the left valve there is a fine bifid anterior tooth representing C2a, having a socket on either side; on the dorsal side of the posterior socket there is a very thin oblique tooth C2p. The laterals are low, elongated. The hinge formula would therefore be—

Right valve	La. : I	C. 3a : 1 :	Lp. I :
Left valve	La. II	C. : 2a : 2p	Lp. II

Pallial impression and muscular scars not observed. Test thin, measuring 0·82 mm. and under in thickness.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—The general shape of the shell, having an extremely long pedal and a comparatively short siphonal region, together with the fine concentric striæ readily distinguish this species.

With regard to the contrast in the relative size of the pedal and siphonal region it might be compared to *Tellina protostriatula*, but this species is easily distinguished by its orbicular shape; it may also be said that the difference in the size of siphonal and pedal region offers the greatest contrast observed in any of the species here described, *Tellina* (*Metis*) *grimesi* perhaps excepted.

Tellina indifferens which might at the first glance bear some relationship, is easily distinguished by its triangular shape, having the umbo nearly terminal and therefore an extremely short pedal and an elongate siphonal region, while nearly the opposite takes place in *Tellina protocandida*.

Among the living species *Tellina candida*, Lam., from the Chinese Seas is unquestionably the nearest relative; this species as well as *Tellina galathæa* from the same region, which is probably only a variety, exhibits the same disproportion between pedal and siphonal region; the pedal region is very elongate, rather broad and rounded off at its extremity; the siphonal region is very short, and the posterior portion of the cardinal margin strongly ventrally inclined, the chief difference which I can discover between *Tellina candida* and the Miocene species, judging from Reeve's figure only, as I have no specimens for comparison, consists in the anterior portion of the cardinal margin being nearly parallel to the ventral margin in the living, and ventrally inclined in the fossil species.

Though different, it is highly probable that *Tellina candida* has developed from the Miocene *Tellina protocandida*, and that it represents a type extinct among the present fauna of the Indian Ocean.

TELLINA INDIFFERENS, spec. nov., Pl. XV., fig. 3, *a-b*.

MEASUREMENTS.

	Length.	Height.	L/H.
Left valve	31·8 mm.	23·3 mm.	1·46.

There is only an isolated left valve which has served for the description; the shell is elongately triangular in shape though the length is not greatly in excess of the height; the index L/H is therefore comparatively small; it is rather inequilateral and moderately flat.

The umbo is low, but pointed and situated so far forwards that it is nearly terminal. The pedal region is therefore very short, though rather broad, the siphonal region is very elongate, broad but slightly contracted towards its extremity.

The anterior margin is short, rounded, forming an angle with the long straight ventral margin; the posterior margin is broadly rounded, passing gradually into ventral and cardinal margin; the cardinal margin is rather long, angularly broken, both parts forming an angle of about 90°; the anterior shorter portion is straight, strongly inclined in ventral direction, passing gradually into the anterior margin; the posterior longer portion is straight, moderately inclined in ventral direction, passing gradually into the posterior margin.

The surface is smooth except some concentric striæ of growth.

The hinge consists of a small, deeply bifid anterior tooth, C2a, separated by a deep socket from a small, oblique, lamellar tooth C2p. There existed apparently no laterals, though I am not quite sure with regard to this feature.

Internal features, muscular scars, pallial impression not observed. Test very thin, measuring not more than 0·47 mm. in thickness.

Geological occurrence.—

Zone of ***Parallelipipedum prototortuosum***, Kama.

Remarks.—By the absence of any ornamentation and the smooth surface this species could only be compared with ***Tellina protostriatula*** and ***Tellina protocandida***; it will, however, be seen that with regard to shape both species differ widely; in ***Tellina protocandida*** the umbo lies far backwards, the pedal region is therefore longer than the anterior one; in ***Tellina indifferens*** the umbo is so close to the anterior margin that it is nearly terminal. The same feature applies to ***Tellina protostriatula***, which in addition is easily distinguished by its orbicular shape.

The only living relative I can discover is ***Tellina triangularis***, Chemn., from China. In this species the contrast between the comparative size of the siphonal and pedal region is, however, not so strongly developed as in ***Tellina indifferens***, the pedal region is a little longer and the siphonal one a little more accuminate in ***Tellina triangularis*** than in ***Tellina indifferens***, and the umbo is much closer to the middle in the living than in the fossil species; these features are in my opinion enough to justify a specific separation; in fact I am not even quite sure whether ***Tellina triangularis*** could be considered as a descendant of ***Tellina indifferens***

though the latter is unquestionably a type which is extinct among the fauna of the Indian Ocean.

TELLINA (PHYLLODA) FOLIACEA, Reeve, Pl. XIV, figs. 3, 3*a*.

Tellina foliacea, Reeve, Monograph of the Genus *Tellina*, Pl. III, fig. 11.

MEASUREMENTS.

(*a*) Left valve.	Length.	Height.	L/H.	(*b*) Right valve.	Length.	Height.	L/H.
(1)	45·6 mm.	2·40 mm.	1·90	(1)	45·0 mm	27·0 mm.	1·70
				(2)	43·2 „	28·3 „	1·53

The shell is of moderate size, triangularly oval, much longer than high, having therefore a large index L/H; it is very flat and nearly equilateral. The umbo is very small, pointed, slightly in front of the middle line. The pedal region is elongated, a little attenuated and rounded, the siphonal region is of about the same size, but accuminated. Anterior margin rounded, passing gradually into the straight, long, ventral margin, which in its turn forms a sharp angle with the short, posterior margin. Cardinal margin very long, angularly broken, the posterior portion is slightly convex, set with irregular, lamellous thorns and passes gradually into the posterior margin; the anterior portion is straight, ventrally inclined and passes gradually into the anterior margin. A sharp keel runs from the umbo towards the posterior corner which is therefore slightly produced; behind it the surface of the shell is more inclined than in front of it.

The ornamentation is very monotonous, consisting chiefly of numerous concentric linear striæ which become less regular in posterior direction and entirely disappear on the posterior field, where they are replaced by striæ of growth. Owing to the worn state of the shell, only a few traces of the punctuate radiæ are seen on the posterior field. At the umbonal region a few, regular, strong concentric wrinkles separated by broad interstices, and limited to the region in front of the keel only, are to be seen; these wrinkles disappear entirely after the shell has reached a height of about 3 mm., whence it becomes entirely smooth. The shell at the nealogic stage must therefore have perfect different appearance from what it looks when it is fully grown up.

The hinge consists of two very small and weak cardinal teeth below the umbo; in none of the specimens is it well seen, but apparently in the right valve the anterior one was considerably weaker than the posterior one. I am not quite sure whether I am right in interpreting these teeth as C1 and C3p; there is also a long and narrow anterior lateral socket, with a thin lamellar anterior lateral below it, which should represent LaI, while the socket corresponds to LaII; there are certainly no posterior laterals. The hinge formula would therefore be—

Right valve	La.	:	I	C.	:	1	:	3p	Lp. O.
Left valve	La.	II	:	C.	2a	:	2p	:	Lp. O.

The test is very thin, measuring not more than 0·81 mm. in thickness.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.
Zone of *Parallelipipedum prototortuosum*, Kama.
Zone of *Pholas orientalis*, Thayetmyo.
Zone of *Aricia humerosa*, Thayetmyo.

Remarks.—There is no fossil species described either from India or from Java and Sumatra, to which this species could be compared, but among the large number of living *Tellinæ* one proves itself at once to be the identical species, *viz.*, *Tellina* (*Phylloda*) *foliacea*, Reeve, from the Philippine Islands. The general shape of both is exactly the same, and as in regard to its shape, *Tellina* (*Phylloda*) *foliacea* is quite unique among the genus, there is no mistake possible.

I have been able to compare a specimen of *Tellina* (*Phylloda*) *foliacea*, Reeve, from the Philippine Islands with the fossil specimen, and I must confess that I was struck at the almost absolute identity. The shape, the wrinkled umbonal region, the ornamentation of the posterior field, and the spinose dorsal part of the cardinal margin were exactly the same.

It must, however, be stated that as the fossil specimens are apparently considerably worn, only very faint traces of the punctuate radiæ on the posterior field, which apparently looked smooth, could be discovered; the lamellous spines on the posterior part of the cardinal margin could also be traced, though owing to their fragile nature only traces remained.

Reeve's figure gives all these features in a somewhat exaggerated way; at least the specimen I have under examination shows only very delicate striæ and spines by no means so strongly developed as in Reeve's figure.

It is, however, quite possible that in some of the living specimens these characters are more strongly developed than in others, and it is also quite possible that they were still less so in the Miocene than in the living species.

TELLINA (TELLINELLA) HILLI,[1] Noetling, Pl. XIV, figs. 7, *a-d*, 8, *a-d*.

1895. *Tellina* (*Tellinella*) *hilli*, Noetling, Miocene Foss. of Upper Burma, Mem. Geolog. Survey of India, Vol. XXVII, Pt. I, p. 13, pl. III, fig. 5-6a.

MEASUREMENTS.

(*a*) Right valve	Length.	Height.	L/H.	(*b*) Left valve.	Length.	Height.	L/H.
(1)	58·3 mm.	21·5 mm.	2·71	(1)	65·0 mm.	24·4 mm.	2·66
(2)	49·6 „	21·6 „	2·30	(2)	51·8 „	18·0 „	2·88
				(3)	26·8 „	13·4 „	2·00

The shell is tranversely triangular in shape, strongly elongated in antero-lateral direction, the length exceeding the height considerably; the index L/H is therefore rather high; although very frequent, complete valves are owing to the size and the delicacy of the shell rather rare; measurements of only a few could therefore be taken, but they seem to prove that the shape is very variable, inasmuch as according to the above figures the variation formula would be, var. $88\ \overset{2\cdot88}{\underset{2\cdot00}{|}}$

[1] Dedicated to Mr. H. C. Hill, late Conservator of Forests, Burma.

This is so far the largest amplitude of variation recorded of any species here described, and as I selected only perfectly preserved specimens these figures are unobjectionable. This great tendency of variation is also unmistakably expressed in the shape; there are not two specimens which are exactly alike.

The shell is slightly inequivalve, inasmuch as the left valve is more inflated than the right one, which is rather flat; it further seems that the posterior extremity of the right valve is slightly twisted, while it is straight in the left valve.

The umbo is very low, depressed, situated nearly in the middle.

The pedal region is long, accuminated, the siphonal region slightly longer, strongly accuminated.

Anterior and ventral margin form a long flat curve, which is slightly sinuated at the posterior end; the posterior margin is very short, slightly rounded, oblique, forming a sharp angle with the ventral margin. Cardinal margin very long, angularly broken; the anterior portion which is the shorter is strongly inclined in ventral direction, forming a very pointed angle with the anterior margin; the posterior portion which is slightly longer, but equally strongly inclined in ventral direction, forms an obtuse angle with the posterior margin.

On the pedal region a strong sharp keel set with raised lamellæ runs from the umbo towards the junction of anterior and cardinal margin; on the siphonal region there are three similar, lamellous keels running from the umbo towards the posterior margin, varying in their development somewhat on both valves; on the right valve the most ventral keel runs from the umbo towards the posterior corner, having on its ventral (anterior) side a broad shallow depression sinuating the ventral margin; on its dorsal side is a sharp furrow, followed by a second keel of smaller strength, running from the umbo towards the middle of the posterior margin, followed by a deep broad furrow, which bears on its dorsal side a strongly lamellous keel running from the umbo towards the junction of posterior and cardinal margin.

On the left valve the arrangement of the three keels is very much the same, the ventral keel running towards the posterior corner, the median one towards the middle of the posterior margin, the dorsal one towards the junction of posterior and cardinal margin. The median keel is, however, very weak, and the furrow separating it from the ventral one very sharp and deep, while it is separated by a linear furrow from the broad, rounded, dorsal keel set on its dorsal edge with sharp lamellæ.

On the central part of the shell the ornamentation consists of numerous, narrow, flat, concentric ribs, separated by deeply engraved linear interstices. In anterior as well as in posterior direction, these ribs become thinner, the interstices broader, till at last on the keels the ribs are raised into sharp scaly lamellæ; some of the ribs may die out before they reach the keel, sometimes they unite in one scale on the keel; having crossed the anterior keel the ribs are reduced to fine sharp concentric lines running parallel to the cardinal margin; on crossing the ventro-posterior keel the ribs turn at a sharp angle of about 80° in dorsal

direction and appear as sharp lines between, and as raised scaly lamellæ on the keels.

In the right valve there is a small bifid tooth below the umbo C1 and in front of it a similar small tooth C3a; there is an elongated anterior lateral LaI having a deep socket on its dorsal side for the insertion of LaII, and there is a similar posterior lateral LpI with a deep socket on its side.

In the left valve there is a larger bifid tooth C2a below the umbo having a deep socket on either side; on the dorsal side of the posterior socket there is a very rudimentary lamellar tooth C2p. Anterior and posterior laterals elongated but low.

The hinge formula is therefore:—

Right valve La. : I	C. 3a : 1 :	Lp. I :
Left valve La. II	C. : 2a : 2p	Lp. II

Pallial impression and muscular scars not observed, therefore apparently only slightly marked.

Test thin, measuring between 1·3 and 1·4 mm. in thickness.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.
Zone of *Paracyathus caeruleus*, Yenangyat.
Zone of *Arca theobaldi*, Kama.
Zone of *Parallelipipedum prototortuosum*, Kama.
Zone of *Pholas orientalis*, Thayetmyo.
Zone of *Aricia humerosa*, Thayetmyo.

Remarks.—The elongated shape together with the ornamentation of the surface readily distinguish this species from any others.

As already pointed out in my previous memoir, *Tellina* (*Tellinella*) *hilli* bears a great similarity to Sowerby's *Tellina exarata;* as, however, Sowerby himself admits that contrary to usual custom, the surface of the shell has been completed by the draftsman, it is impossible to say how many of the characters of the figure are natural and how many have to be attributed to the lithographer's skill; I refrain therefore from further conclusions, which would be of no value.

Under the name of *Tellina* (*Tellinella*) *verbecki*, Bœttger describes a species from Sumatra, which is probably closely allied if not identical with the species here described. Bœttger states, however, that it is devoid of an anterior keel and compares it, therefore, with two species, *T. rostralis*, Lam., and *T. pseudorostralis*, d'Arch., from the French Eocene. I must confess that I cannot agree with Professor Bœttger in this regard; both species seem to me, at least as I am able to judge from the figures, considerably different from the Sumatran species; with regard to the anterior keel the question might be raised whether its absence is not perhaps accidental, owing to the state of preservation; if this opinion should prove correct, *Tellina* (*Tellinella*) *hilli* would be identical with *Tellina* (*Tellinella*) *verbecki*, but if the anterior keel would really be absent it would form a very good distinguishing feature.

It may also be questioned whether *Tellina* (*Tellinella*) *sumatrana*, Bœtt., is really specifically different from the above-named species; in fact I rather think that the differences on which Bœttger separates this species are chiefly due to the state of preservation; that the size of the index L/H alone is not sufficient for a specific separation has been repeatedly demonstrated.

It is, therefore, beyond any doubt that *Tellina* (*Tellinella*) *hilli* exhibits a great similarity to two species from the Lower and Middle Miocene of Sumatra, which are probably identical among themselves.

With regard to the living relatives, Bœttger has already recognized that *Tellina rostrata*, Lin., is a very near relative to both his species, but to me it is quite certain that in *Tellina rostrata*, Lin., from the Philippine Islands we have a species which is so nearly related to *Tellina* (*Tellinella*) *hilli* that it is most probably the direct descendant of this species.

Tellina rostrata has the same very elongated shell having a high index L/H (the specimen figured by Reeve has an index L/H=2·98); there are the same scaly keels on the anterior and posterior region running close to cardinal margins. Reeve's figure shows, however, that the cardinal margin of *Tellina rostrata* was set with scales, while it was certainly smooth in *Tellina* (*Tellinella*) *hilli*. This is probably an evolutionary feature, unless it is demonstrated that this character is somewhat exaggerated, as I repeatedly noticed to be the case in some of Reeve's figures. Having, however, no specimen for comparison, I am unable to say how far the differences between *Tellina* (*Tellinella*) *hilli* and *Tellina rostrata* go; it may be possible that both species are identical, but it is more likely that as I already said the living species is the direct descendant of the Miocene species.

Tellina hilli is certainly a type which is not represented among the fauna of the Indian Ocean.

Tellina (Tellinella) pseudohilli, spec. nov., Pl. XIV, fig. 9, *a-e*.

Measurements.

	Length.	Height.	L/H.
Right valve	30·1 mm.	16·4 mm.	1·83

The shell is transversely triangular in shape, the length exceeding the height considerably, the index L/H is therefore rather high, it is almost equilateral and very flat. The umbo is low, strongly depressed and situated nearly in the middle.

Both pedal and siphonal region are nearly of the same length, elongated and acuminated. The anterior margin is very short and fully merged into the ventral margin, both forming a long broadly rounded curve, which is just perceptibly sinuated at its posterior end. The posterior margin is apparently short, oblique, forming a sharp pointed angle with the ventral margin. The cardinal margin is long, angularly broken; both portions are of almost the same length, ventrally inclined, the anterior portion forming a pointed angle with the antero-ventral margin.

On the pedal region a very indistinct keel runs from the umbo towards the

junction of the antero-ventral and cardinal margin, while there are two similar keels, separated by a broad furrow running from the umbo towards the posterior margin.

The whole surface of the shell is covered with numerous, fine, sharp, lamellar concentric ribs, separated by broad concave interstices; the ribs are a little irregular inasmuch as a finer filiform rib is sometimes intercalated between two stronger ones; the ribs cross the keels, but it apparently does not come to the formation of raised lamellous scales.

In the right valve the hinge consists of a minute bifid tooth below the umbo, C1, having a narrow socket on either side; there seems to be a very rudimentary tooth on the dorsal side of the anterior socket corresponding to C3a; there is a moderately strong, elongate anterior and posterior lateral LaI and LpI having a deep socket on the dorsal side. The hinge formula should therefore be—

Right valve	La. : I	C.3a : 1 :	Lp. I :
Left valve	La. II	C. : 2a : 2p.	Lp. II

Pallial impression and muscular scars not observed.

Geological occurrence.—

Zone of ***Parallelipipedum prototortuosum***, Kama.

Remarks.—At the first glance this species might be considered as identical with ***Tellina*** (***Tellinella***) ***hilli***, but on closer examination the difference will be readily noticed. ***Tellina*** (***Tellinella***) ***pseudohilli*** appears to be less elongate and higher in shape, that is to say, the average index L/H is smaller than in ***Tellina*** (***Tellinella***) ***hilli***; of course further observation would be required to ascertain this view, but if we assume the average index L/H of the former to be 2·445, that of ***Tellina*** (***Tellinella***) ***pseudohilli*** would be 1·83 only.

The chief difference rests, however, in the ornamentation, which consists in raised sharp ribs throughout, separated by broad interstices, while in ***Tellina*** (***Tellinella***) ***hilli*** the ribs are raised and lamellar at their extremities only, and on the ventral portion of the shell they are broad, flat, separated by linear interstices. It further seems that there existed only two posterior keels in ***Tellina*** (***Tellinella***) ***pseudohilli*** which apparently were never set with such sharp raised scales which are so prominent a feature of ***Tellina*** (***Tellinella***) ***hilli***. Unfortunately I have only two specimens of ***Tellina*** (***Tellinella***) ***pseudohilli*** one, of which is very much worn, and I am therefore not in a position to say how far the last two characters are really distinctive, but this does not matter much as the character of the ornamentation unquestionably proves that the two species are different; but after all it is probable that it forms only a variety of ***Tellina*** (***Tellinella***) ***hilli***; we know that this species exhibits a great amplitude of variation with regard to its shape, and it is not impossible that a similar feature may exist with regard to the ornamentation, although I must say that none of my numerous specimens of that species exhibited any tendency of variation in this regard.

It is not impossible that this species is the ancestor of either ***Tellina planispinosa***, Sow., from the Mollucas or ***Tellina rostellum***, Hanley, from the Philippine

Islands, though on account of the want of material for comparison I am unable to say anything definite. The probabilities are in favour of a relationship with *Tellina rastellum*, and the larger shape and coarser sculpture of this species would be quite in harmony with the view of regarding it as the descendant of *Tellina (Tellinella) pseudohilli*.

Tellina (Tellinella) pseudohilli represents a type which is unquestionably extinct among the fauna of the Indian Ocean.

2. Genus: GARI, Schumacher.

This genus has yielded four species which are very closely related to each other, but while one species, *Gari natensis*, can at once be distinguished from the remaining three, these latter represent clearly different stages of evolution; the oldest, *Gari protokingi*, exhibiting the finest, the youngest, *Gari deuterokingi*, the coarsest ribs. *Gari protokingi* is a delicate species, having fine sharp ribs of which there are 4 ribs and 3 interstices to 1 mm. of height; in the next younger species *Gari kingi* there are 3 ribs and 2 interstices to the same height, and in the youngest, *Gari deuterokingi*, which at the same time attains the largest size, there are 2 ribs and 1 interstice to 1 mm. of height.

The species may therefore easily be distinguished as follows:—

A. Ribs flat, no posterior keel.

1. *Gari natensis*, spec. nov.

B. Ribs rounded, strong posterior keel.

(a) 4 ribs and 3 interstices to 1 mm. of height.

2. *Gari protokingi*, spec. nov.

(b) 3 ribs and 2 interstices to 1 mm. of height.

3. *Gari kingi*, Noetling.

(c) 2 ribs and 1 interstice to 1 mm. of height.

4. *Gari deuterokingi*, spec. nov.

Gari natensis represents unquestionably a type extinct among the fauna of the Indian Ocean, though it has its nearest relative apparently in a species from the Philippine Islands. The other three species represent an interesting group, inasmuch as though all of them are extinct species, *Gari caerulescens*, Reeve, which inhabits the Indian Ocean is a direct descendant of *Gari deuterokingi* which itself through *Gari kingi* is a descendant of *Gari protokingi*.

GARI NATENSIS, spec. nov., Pl. XV, fig. 6, *a-c*.

MEASUREMENTS.

(a) Left valve.

	Length.	Height.	Thickness.	L/H.
(1)	19·8 mm.	11·3 mm.	2·5 mm.	1·75
(2)*	19·7 „	11·1 „	?	1·77

(b) Right valve.

	Length.	Height.	Thickness	L/H.
(3)	17·3 mm.	10·2 mm.	3·0 mm.	1·70
(4)*	15·6 „	9·1 „	?	1·70

* Both valves united.

Only four specimens have come under examination, but all of them are well

preserved, two having in fact still both valves united. The shell is apparently the smallest of the species here examined; it is inequilateral, considerably longer than high, transversely elliptical in shape and very flat. The umbo is very low, depressed, situated behind the middle; the pedal region is elongate, somewhat attenuated, the siphonal region is a little shorter, expanded and obliquely truncated. Anterior margin short, rounded, passing gradually into the long very slightly curved ventral margin, which forms an obtuse angle, the corner of which is rounded off, with the short oblique posterior margin. Cardinal margin long, angularly broken; posterior part straight, forming an obtuse angle with the posterior margin, anterior part inclined, passing gradually into the anterior margin. An indistinct, flat keel runs from the umbo towards the posterior corner; behind it the surface is a little inclined; and a hardly perceptible, second keel or radial fold runs from the umbo towards the middle of the posterior margin; in front of the keel the shell is a little flattened, even concave.

The ornamentation is very delicate; on the larger anterior part it consists of numerous, very regular, concentric, engraved lines, with broad, flat interstices between them; in posterior direction the interstices become narrower, while the lines are gradually raised into sharp lamellar striæ, becoming at the same time more oblique; some of the lines terminate suddenly, while the remainder continue on the posterior part; generally one line terminates, while two run on, but there may be also only one running on, particularly towards the ventral region. As all the lines terminate at the same point, the posterior part with its fine lamellar ribs separated by broad flat interstices, looks very different from the anterior one, a difference which is increased by the smooth polished appearance of the anterior part forming a great contrast to the dull-looking posterior part.

The ligament was very long, its anterior part supported by a strong nymphe.

In the left valve there is a small bifid tooth below the umbo and a very rudimentary tooth behind it. I am not quite sure how these teeth should be interpreted; the probability is that they represent C2a and C2p. There are also two extremely rudimentary, short anterior and posterior laterals, with a hollow socket in dorsal direction; the hinge formula should therefore be—

Right valve	La. I :	C. 3a : 1	Lp. : I
Left valve	La. II	C. : 2a : 2p	Lp. II

The above formula would differ from the general hinge formula of *Gari* by the presence of laterals, as so far as it is known to me they are missing in all the living species. In this species the anterior laterals are very rudimentary, in fact hardly visible, while there is no doubt as to the existence of the posterior laterals, which though obsolete are still distinctly discernible.

Only the posterior muscular scar is well seen, the anterior one is ill-defined; pallial impression very faint, not visible; margin sharp.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—This species is very similar to *Gari protokingi*, but it is easily distinguished by the peculiar ornamentation, as there are no rounded ribs like the latter has; the absence of a sharp posterior keel, with its deep furrow in front of it, is also a very good distinguishing feature.

The nearest living relative appears to be *Gari puella*, Reeve, which nowadays inhabits the waters of Australia; unfortunately I have no specimens for comparison to verify this view, but it is unquestionable that even if this view is not correct, the nearest relatives, such as *Gari corrugata*, Reeve, live in the Philippine Islands. It is unquestionable that *Gari natensis* represents a type which is extinct among the present fauna of the Indian Ocean.

GARI PROTOKINGI, spec. nov., Pl. XV, figs. 7, *a-d*, 8, *a-c*, 9, *a-c*.

MEASUREMENTS.

(*a*) Right valve.

Length.	Height.	Thickness.	L/H.
(1) 29·1 mm.	15·8 mm.	4·6 mm.	1·88
(2) 23·7 „	10·9 „	?	2·17
(3) 23·6 „	12·5 „	3·0 „	1·87
(4) 21·4 „	10·9 „	2·6 „	1·96
(5) 20·8 „	10·6 „	?	[illegible]
(6) 17·6 „	8·5 „	?	2·06

(*b*) Left valve.

Length.	Height.	Thickness.	L/H.
(1) 21·7 mm.	10·3 mm.	?	2·10
(2) 21·6 „	10·7 „	?	2·01
(3) 21·4 „	11·9 „	?	1·80
(4) 21·9 „	10·8 „	2·5 mm.	1·93
(5) 20·7 „	12·0 „	?	1·72
(6) 20·5 „	10·8 „	2·8 „	1·89
(7) 20·3 „	10·4 „	?	1·95
(8) 17·4 „	8·5 „	?	2·04

The shell is very inequilateral, very flat, considerably longer than high, transversely elliptical in shape; it exhibits a strong tendency towards variation in shape as will be seen from the above figures; the amplitude is rather a large one extending from 1·72 to 2·17, though more material would be required to fill up the gaps. According to these figures the formula of variation would be—

$$\text{var. } 1{\cdot}72 \overset{45}{\underset{2{\cdot}17}{\Big|}},$$

the mathematical average being 1·945, the calculated one 1·952. As far as the scanty material allows of any conclusions, we see that about 29°/₀ of the total number are grouped around these figures. The umbo is low, depressed, situated behind the middle line; the pedal region is elongated, somewhat attenuated; the siphonal region is a little shorter, expanded and obliquely truncated. Anterior margin short, rounded, passing gradually into the long, slightly curved ventral margin which at its posterior end turns abruptly in dorsal direction and forms an obtuse angle with the short, straight, posterior margin. Cardinal margin long, angularly broken; the shorter posterior portion which runs nearly parallel to the ventral margin, forms an obtuse angle with the posterior margin, while its longer anterior portion is ventrally inclined and gradually passes into the anterior margin. A strong and sharp keel runs from the umbo towards the posterior corner, accompanied in front by a moderately narrow depression, the anterior side of which is indistinctly keeled. The surface drops slightly behind the main keel, and on this field there is still another, but hardly perceptible keel which runs from the umbo towards the middle of the posterior margin.

On the anterior part the shell is covered with numerous very fine, flat, concentric ribs with linear interstices between them; in posterior direction the ribs become thinner, and eventually assume the shape of sharp, raised lamellæ, while at the same time the interstices increase in breadth, both crossing the posterior keels and furrow without interruption or without any of the lamellæ terminating in front of the furrow. There are very exactly 4 ribs and 3 interstices to 1 mm. in height.

In addition to the above ornamentation the shell had during the nealogic stage strong concentric wrinkles, separated by broad concave interstices, which, however, terminated abruptly after the height had increased above 3 mm., and in adult specimens this secondary ornamentation is only seen in the umbonal region.

The ligament is long, its anterior part supported by a strong nymphe.

In the right valve there are two small cardinal teeth, separated by a deep triangular socket; the anterior is the larger, very oblique and has a shallow socket on its dorsal side; it should represent C3a; the posterior tooth which is bifid represents C1; there is a very rudimentary posterior lateral Lp I with a shallow socket on its dorsal side. The hinge formula should therefore be :—

Right valve	La. O	C. 3a : 1 :	Lp. : I
Left valve	La. O	C. : 2a : 2p.	Lp. II

Muscular scars and pallial impression not seen.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—From *Gari natensis* this species is easily distinguished by its different ornamentation, in particular by the strong posterior keel, and the concentric sculpture continuing posteriorly, without the ribs, terminating abruptly in front of the keel. As a further mark of distinction may be mentioned, though this is not very conspicuous, that the index L/H is apparently larger; in other words, that the shell of *Gari protokingi* is apparently much more elongate than that of *Gari natensis.*

Its nearest relative is *Gari kingi*, and I hesitated in fact for some time whether the two species could be separated; on further examination the following differences were noticed which seem to me sufficient to establish the specific difference particularly when it is kept in mind that both occur in different strata.

As far as the scanty material of *Gari kingi* allows of a conclusion, the average index L/H 1·827 of this species is smaller than of *Gari protokingi* which is 1·952; the shell of the latter is therefore in the average a little more elongate than that of *Gari kingi*. The chief difference rests, however, in the sculpture; in *Gari protokingi* there are fine concentric ribs, of such a strength that 4 ribs and 3 interstices go to 1 mm. in height: measured at the same place, there are in *Gari kingi* only 3 ribs and 2 interstices to 1 mm. in height; the sculpture is therefore much coarser. This is such a characteristic difference, that even fragments of the two species can easily be distinguished. It is unquestionable that *Gari kingi* is the direct

descendant of *Gari protokingi*, and that the tendency of evolution has been towards the formation of a coarser sculpture.

GARI KINGI, Noetling, Pl. XV, figs. 11, 11*a*, 12, 12*a*, 13, 13*a*.

1895. *Tellina kingi*, Noetling, Mar. Foss. from Mioc. of Upper Burma, Mem. Geolog. Survey of India, Vol. XXVII, Pt. 1, p. 14, pl. III, figs. 7, 7*a*.

MEASUREMENTS.

(*a*) Rigth valve.	Length.	Height.	L/H.	(*b*) Left valve.	Length.	Height.	L/H.
(1)	24·3 mm.	13·5 mm.	1·80	(4)	24·9 mm.	13·3 mm.	1·87
(2)	21·3 „	11·8 „	1·80				
(3)	19·7 „	10·7 „	1·84				

The small shell is always considerably longer than high, it is transversely oval in shape, inequilateral and very flat. The umbo is pointed, but low, and situated as nearly as possible in the middle line. The pedal region is broadly attenuated, the siphonal one expanded and truncated. The anterior margin is short and rounded, passing gradually into the very slightly curved, ventral margin; whether the latter turns at its end abruptly in posterior direction is not distinctly visible, but it is very probable. It formed apparently an obtuse angle with the straight posterior margin. The cardinal margin is long, angularly broken, the posterior part is parallel to the ventral margin forming an obtuse angle with the posterior margin, while the anterior portion is ventrally inclined and gradually passes into the anterior margin.

A strong and sharp keel runs from the umbo towards the posterior corner, in front of which there is rather a deep, but narrow furrow, which is bordered on its anterior side by another but weaker keel. A third, very indistinct, keel, runs from the umbo towards the middle of the posterior margin.

On the anterior part the shell is covered with numerous, somewhat irregular and slightly undulating, concentric filiform ribs, which are separated by sharply engraved linear interstices. In posterior direction some of the ribs die out, while the remaining ones gradually become flatter, and at the same time broader, the interstices remaining of the same breadth; both cross uninterruptedly keels and furrow, terminating at the cardinal margin, being, however, angularly broken by the hindmost keel, a feature which is, however, not well exhibited in all specimens.

Geological occurrence.—

Zone of *Meiocardia metavulgaris*, Singu.
Zone of *Paracyathus caeruleus*, Yenangyat.
Zone of *Cancellaria martiniana*, Minbu.

Remarks.—I based this species originally on a few fragments from Minbu and Yenangyat, which exhibited the characteristic features of the posterior region. Not knowing the general shape nor the characters of the hinge, I assumed it to belong to the Genus *Tellina*, but in the meantime better preserved material has been

collected by me at Singu, which enables me to give a fuller description. The information thus gained has proved that the generic position was wrong, and as at the same time the hinge of related species could be studied, the generic name "*Tellina*" had to be changed for *Gari*.

As I have dwelt at some length on the differences between *Gari kingi* and *Gari protokingi*, it only remains to be added that the concentric wrinkles in the umbonal part of the latter species are no longer visible in *Gari kingi*. It may further be remarked that a feature which is so conspicuously developed in the next younger species, *Gari deuterokingi*, *viz.*, the dying out of the concentric ribs before the posterior keel is reached, is just indicated in this species, we must recollect that no such feature was indicated in *Gari protokingi*.

It may also be noted that there is a difference with regard to the mutual relation of ribs and interstices in the two species. In *Gari protokingi* we noticed that the number of ribs and interstices is the same in front and behind the keel, but the breadth of the interstices increases at the expense of the ribs.

In *Gari kingi* there is a smaller number of ribs behind than in front of the keel; the number of ribs has been reduced by the dying out of several of them and the remainder have increased in breadth, while the interstices have remained the same. We shall presently see how this feature has further developed in *Gari deuterokingi*.

GARI DEUTEROKINGI, spec. nov., Pl. XV, fig. 10, *a-b*.

Unfortunately only a single specimen of this species has come under examination, and even this is considerably damaged at its posterior part, but it exhibits some features which are of great interest.

The shell seems to have been taller than any of the species hitherto described, as it measures 18·5 mm. in height which would answer to a length of 33·8 mm. when the average index of *Gari kingi* would be applied; it seems, however, that the length was a little smaller, and the index of this species would therefore be smaller too, a feature which would quite be in harmony with the evolutionary tendency of these species. However that may be, it is certainly the largest species of all; its shape is transversely elongate, elliptical and probably much the same as that of *Gari kingi*. The umbo is low, depressed; the cardinal margin is angularly broken, the posterior part being straight and parallel to the ventral margin, the anterior one ventrally inclined.

A strong keel runs from the umbo towards the posterior corner; the depression in front of the keel is shallow and narrow, its anterior side being, however, well marked by a sharp keel; the third or hindmost keel is very indistinct and only well visible on the right valve.

Owing to the beautifully preserved state of the surface, the ornamentation can be studied nearly up to the umbo. The ornamentation of the umbonal region proves that during the nealogic stage it consisted of numerous very fine concentric ribs, which were broader than the linear interstices at the anterior part of the shell, but

became thinner on the posterior part, while the interstices increased in breadth; no dying out of ribs can be observed. As it will be seen this is the stage represented by *Gari protokingi*.

In the next stage we see that some of the ribs die out in posterior direction, while the remainder increase in breadth on the posterior side of the shell; this is the stage of *Gari kingi*.

The evolution has, however, gone further; the ribs begin to take an oblique curvature by becoming more and more ventrally inclined; at the same time they increase in strength, so that only 2 ribs and 1 interstice go to 1 mm. in height. As apparently not all the ribs can reach the posterior keel, more and more of them die out, while those which continue, are forced to bend in dorsal direction in order to come close up to a preceding rib. This bending of the ribs in front of the anterior keel is a most marked feature in this species, and it has been just indicated in some specimens of *Gari kingi* without, however, coming to perfection. Towards the ventral margin the five last ribs resume again an entirely horizontal run, thus being in marked contrast to the preceding oblique ones.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.

Remarks.—It may seem as if there was no reason for separating *Gari deuterokingi* from *Gari kingi*, but if the ornamentation of the latter species is studied as above, it will be seen that a specific distinction is fully justified.

Gari deuterokingi differs from *Gari kingi* by a larger size, stronger ribs, and by the ribs being for the most part obliquely inclined; in addition it may be remarked that *Gari deuterokingi* occurs in a younger bed.

The species here described having been proved to be the direct descendant of *Gari protokingi* through *Gari kingi*, it remains to be examined which is the nearest living relative. This is unquestionably *Gari cærulescens* from the Indian Ocean; in this species the angle of the cardinal margin is apparently still more obtuse, and the anterior region therefore less attenuated than in any of the specimens here described; the whole surface is apparently covered with oblique ribs, their posterior bend is well marked.

3. Genus: HIATULA, Modeer.

Hiatula textilis, spec. nov., Pl. XV, fig. 14, *a-b*.

Measurements.

	Length.	Height.	L/H.
Left valve	27·2 mm.	13·2 mm.	2·06

The shell is nearly rectangular in shape, the length exceeding the height considerably; the index L/H is, therefore, rather high; it is very flat and rather inequilateral.

The umbo is low, depressed, situated considerably in front of the middle line.

The pedal region is short, but broad, rounded; the siphonal region is elongate, broad and rounded.

The anterior margin is rounded; the ventral margin long, straight, abruptly turned upwards at either end, passing gradually into the anterior and posterior margin; posterior margin broadly rounded; cardinal margin long, straight, parallel to the ventral margin; the anterior portion is shorter than the long posterior part which is slightly ventrally inclined.

The surface is smooth, except some irregular concentric striæ of growth.

In the left valve there is a minute tooth having a socket on either side right under the umbo, probably representing C2p.

The ligament is supported by rather strong but short nymphes.

Pallial impression and muscular scars not observed, probably only faintly marked. Test very thin, measuring 0·48 mm. in thickness.

Geological occurrence.—

Zone of *Parallelipipedum protatortuosum*, Kama.

Remarks.—The material I have for examination is rather insufficient, and I am unable to say whether perhaps the species did not attain a larger size.

From *Gari protokingi*, with which it might perhaps be compared with regard to the general outline of the shell, it is easily distinguished by the smooth surface.

I have not found any fossil species to which it could be compared, none having been described from either Java, Sumatra or Western India. With regard to living species I am for want of material for comparison unable to say which may be its nearest relative, but it appears to represent a type which is extinct among the fauna of the Indian Ocean.

Family: *SOLENIDÆ.*

1. Genus: SOLECURTUS, Blainville.

SOLECURTUS EXSULCATUS, spec. nov., Pl. XV, fig. 15.

Only a single ill-preserved left valve has come under examination, but though rather ill-preserved, it is sufficient to allow for a specific distinction.

The shell is transversely rectangular, considerably longer than high, and though exact measurements could not be taken. it is quite certain that the index L/H is rather high; it is very flat and inequilateral.

The umbo is low, depressed, situated considerably in front of the middle line.

The pedal region is high, but short and rounded; the siphonal region is very elongate, slightly accuminated.

Anterior margin broadly rounded, ventral margin straight, posterior margin broadly rounded, apparently parallel to the anterior margin, cardinal margin long, inequilateral, the anterior part much shorter than the posterior one, both slightly inclined in ventral direction.

Anterior portion of the surface smooth, except for some fine striæ of growth; posterior portion provided with sharp, fine ribs which generally run parallel to the posterior margin; the anterior part of the rib is, however, slightly oblique, while

the hindmost are perpendicular to cardinal and ventral margin; their cardinal end turning, however, sharply in anterior direction; the ribs are separated by very broad, flat interstices.

Geological occurrence.—

Lower Miocene, Thayetmyo.

Remarks.—Shape and ornamentation allow no doubt as to the generic position, though the specific determination seems somewhat uncertain. No species belonging to this genus has been described from Java, Sumatra or Western India, and for comparison with fossil species from Europe its state of preservation is not sufficient; I therefore prefer to abstain from any comparison in order not to draw misleading conclusions. The same applies of course to living species, though there seems to be some probability that the living *Solecurtus exaratus.*, Phil., from China, is a close relative of the Miocene species from Burma; on the other hand, no similar species could be found among the fauna of the Indian Ocean, and it is therefore probable that it represents an extinct type.

2. Genus: SOLEN, Linné.

SOLEN, spec.

There are several fragments of a shell, which by their characteristic, elongate, rectangular shape, and the large index L/H unquestionably prove the existence of this genus. None of them is, however, sufficiently well preserved to allow of its features being studied and its specific characters being fixed. In fact, it is even impossible to say whether the fragments represent one or more species, as some of them belong to small specimens, while others clearly demonstrate that the shell must have attained a considerable size, and are distinguished by an extremely thin shell measuring 0·37 mm. and under in thickness; as both occur in the same bed, it is quite possible that the small specimens represent only the adolescent stages of the large ones.

Geological occurrence.—

Zone of *Pholas orientalis*, Thayetmyo.

Zone of *Cancellaria martiniana*, Minbu.

Family: *MACTRIDÆ.*

Genus: MACTRA.

MACTRA PROTOREEVESII, spec. nov., Pl. XVI, figs. 1, *a-d*, 2, *a-d*.

MEASUREMENTS.

	Length.	Height.	L/H.		Length.	Height.	L/H.
(*a*) Complete valve.	20·4 mm.	14·5 mm.	1·45	(*c*) Left valve.	22·7 mm.	16·0 mm.	1·41
(*b*) Right valve.	26·1 mm.	19·0 mm.	1·38				

The shell is transversely triangular in shape, the length exceeding the height

slightly; the index L/H is therefore relatively small, as far as can be judged from the few measurements; it is rather flat, but very inequilateral.

The umbo is inflated, pointed and strongly prosogyric, situated considerably behind the middle line.

The pedal region is very long, broadly rounded; the siphonal region is very short, and accuminated. The anterior margin is broadly rounded and passes gradually into the almost straight, only slightly convex ventral margin; posterior margin short, entirely merged into the cardinal margin and forming a pointed angle with the ventral margin. Cardinal margin long, angularly broken; the anterior part, which is the longer, is slightly concave, ventrally inclined and passes abruptly into the anterior margin; the posterior part is slightly convex strongly sloping in ventral direction, passing gradually into the posterior margin.

From the top of the umbo a broad keel which is flattened at the top having therefore two sharp edges, runs towards the posterior corner, the surface dropping steeply behind it.

During the nealogic stage the ornamentation consists of broad concentric ribs separated by broad concave interstices; in adult specimens this ornamentation is seen on the umbonal region, but owing to its delicacy, it is easily worn off; this ornamentation becomes soon effaced and is replaced by fine concentric striæ of growth.

The hinge is composed as follows :—

a. Right valve.

1. Anterior lateral teeth.

There are two long, thin, lamellar, strongly opisthocline anterior laterals, LaIII and LaV; the ventral LaIII is much longer and stronger than LaV, being raised at its middle into a high knob. The dorsal tooth LaV is very thin, a little undulating, high at its anterior, low at its posterior end, but shorter than LaIII, being separated by a deep elongate socket from it; it is well set off against the margin by a deep furrow.

2. Cardinal teeth.

The anterior cardinal C3a is thin, lamellar, strongly opisthocline, having a deep socket at its posterior (ventral) side; it is joined at its apex to C3p; the latter tooth is thin, lamellar, strongly prosocline, forming a $\wedge$ shaped composite tooth with C3a, the apex of which is right underneath the umbo; behind it follows the deep internal ligamental socket.

3. Posterior lateral teeth.

There are two posterior lateral teeth LaIII and LaI; both are thin, lamellar, elongate and strongly prosocline; the ventral LaI is much stronger than the dorsal LaIII, separated from it by a deep narrow socket; both teeth are highest at their anterior extremity and decrease in posterior direction. LpIII is shorter, thinner and well set off from the margin.

b. Left valve.

1. Anterior lateral teeth.

At the first instance it seems as if there was only one lamellar, thin, opisthocline

anterior lateral, well set off from the margin by a deep furrow, and well forward of the umbo; under ordinary circumstances one would have unhesitatingly interpreted it as LaII, but it is unqestionably on the dorsal side of LaIII when the valves are closed and must, therefore, represent La IV. On its posterior, ventral side, separated by a shallow socket there is a thin, lamellar and strongly opisthocline tooth which might be considered as a cardinal; on closer examination it will, however, be seen that the anterior continuation of this tooth passes on the ventral side of LaIV, although becoming very rudimentary; it must, therefore, unquestionably represent the true LaII which imitates shape and position of an anterior cardinal tooth.

2. Cardinal teeth.

The anterior cardinal tooth C2a is very thin, lamellar, strongly opisthocline, having a narrow socket on its anterior (dorsal) and a broad triangular socket on its posterior (ventral) side; its apex is joined to C2p; this tooth is very thin, lamellar, strongly prosocline and joined to C2p forming a ∧ shaped composite tooth, the apex of which is right underneath the umbo; behind it is the triangular ligamental socket.

3. Posterior lateral teeth.

There is only one large, lamellar, strongly prosocline tooth LpII, having a rather broad socket on its dorsal side.

The hinge formula is, therefore, as follows:—

Right valve	La. V	: III	:	C. 3a	: O^1	: 3p	Lp. III	: I.
Right valve	La.	: IV	: II	C.	: 2a	: 2p :	Lp.	II

Ligamental groove, triangular, small, but deeply concave, anteriorly inclined. Pallial impression and muscular scars not observed, apparently ill-marked. Test very thin, measuring not more than a ·66 mm. in thickness.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.

Zone of *Pholas orientalis*, Thayetmyo.

Remarks.—Among the large number of species belonging to the genus *Mactra* none is so conspicuous by the disproportion between the size of the pedal and siphonal region as *Mactra protoreevesii*. The extremely elongate anterior and the short accuminate posterior region characterize this species exceedingly well.

It was for this characteristic shape of the shell that I at once recognised that the Miocene specimen must be very closely related to *Mactra reevesii*, Deshayes, from Malacca, and when I found that the fossil specimens exhibited the same concentric ribs on the umbonal region though in a more delicate state, I asked myself whether I was not justified in identifying both specimens. It is, however, unquestionable that, in harmony with the observation made in other species, the whole of the characters of the living specimens are of a somewhat larger, stronger style than in the fossil species, and acting on the principles observed in other species, I prefer to distinguish it under a special name. It is, however, quite unquestionable that *Mactra reevesii* is the direct descendant of the Miocene *Mactra protoreevesii*, being distinguished by coarser features only, though it seems unquestionable that it represents a type which is extinct among the fauna of the Indian Ocean.

Family: *MYIDÆ,* Deshayes.

Genus: CORBULA, Brugière.

Three well characterised species have been described which can be easily distinguished as follows :—

A. Both valves covered with concentric ribs.

(*a*) Right and left valve completely covered. Shell transversely oval.

1. *Corbula socialis*, K. Martin.

(*b*) Right valve completely, left valve only towards the ventral margin covered with ribs, shell rhomboidal.

2. *Corbula rugosa*, Sowerby.

B. Right valve covered with concentric ribs, left valve smooth.

3. *Corbula prototruncata*, spec. nov.

One species, *Corbula rugosa*, Sow., represents apparently a type which is extinct among the present fauna of the Indian Ocean. *Corbula prototruncata* is apparently the permanent nealogic stage of *Corbula truncata*, Sow., inhabiting the Indian Ocean, while *Corbula socialis*, K. Martin, is undoubtedly the Miocene ancestor of *Corbula crassa*, Hinds, from the Indian Ocean.

CORBULA SOCIALIS, K. Martin, Pl. XVI, figs. 3, *a-e*, 4, *a-b*, 5, *a-e*.

1879-80. *Corbula socialis*, K. Martin, Die Tertiärsch. auf Java, p. 92, pl. XV, fig. 10.

MEASUREMENTS.

(*a*) *Right valve.*

	Length.	Height.	L/H.
(1)	17·5 mm.	11·6 mm.	1·52
(2)	17·0 „	11·2 „	1·51
(3)	14·8 „	9·2 „	1·60
(4)	14·0 „	9·3 „	1·50
(5)	13·4 „	9·0 „	1·49
(6)	13·2 „	9·3 „	1·41
(7)	13·0 „	8·9 „	1·34
(8)	12·7 „	9·0 „	1·41
(9)	12·4 „	8·8 „	1·40
(10)	12·2 „	8·5 „	1·41
(11)	12·1 „	8·9 „	1·35
(12)	12·0 „	7·7 „	1·55
(13)	11·9 „	8·5 „	1·40
(14)	11·6 „	8·7 „	[illegible]
(15)	11·5 „	8·0 „	1·43
(16)	11·1 „	7·6 „	1·46
(17)	10·8 „	8·6 „	1·25
(18)	10·8 „	7·7 „	1·40
(19)	10·8 „	7·5 „	1·44
(20)	10·7 „	7·5 „	1·42
(21)	10·1 „	6·4 „	1·57
(22)	9·2 „	6·9 „	1·33
(23)	6·9 „	4·1 „	1·68

(*b*) *Left valve.*

	Length.	Height.	L/H.
(1)	17·2 mm.	9·6 mm.	1·81
(2)	14·9 „	9·0 „	1·65
(3)	14·4 „	8·2 „	1·75
(4)	13·7 „	8·8 „	1·55
(5)	12·8 „	7·8 „	1·64
(6)	12·4 „	7·7 „	1·61
(7)	12·8 „	7·2 „	1·70
(8)	12·0 „	8·0 „	1·50
(9)	12·0 „	7·1 „	1·66
(10)	11·9 „	7·8 „	1·53
(11)	11·5 „	7·0 „	1·64
(12)	11·4 „	7·4 „	1·54
(13)	11·1 „	7·8 „	1·42
(14)	9·6 „	6·1 „	1·42
(15)	9·8 „	6·9 „	1·42
(16)	9·2 „	5·9 „	1·56
(17)	8·0 „	5·0 „	1·60

The shell is slightly inequivalve, although both valves have very much the same transversely triangular shape, the length of which always exceeds the height. So far as can be judged from the material at my disposal, which is rather insufficient for the purposes referred to below, the index L/H affords some very interesting features particularly if both valves are considered separately.

(*a*) *Right valve.*—Glancing through the figures as given above, it will be seen that the index is quite independent of size, large valves having rather a small, the smallest specimen, rather a high index; if arranged according to the index the following table is obtained:—

Index . . .	1·25	1·26	1·27	1·28	1·29	1·30	1·31	1·32	1·33	1·34	1·35	1·36	1·37
Number of specimens	1	...	...	...	...	...	..	...	2	1	1	...	...
Index . . .	1·38	1·39	1·40	1·41	1·42	1·43	1·44	1·45	1·46	1·47	1·48	1·49	1·50
Number of specimens	...	...	3	3	1	1	1	...	1	...	...	1	1
Index . . .	1·51	1·52	1·53	1·54	1·55	1·56	1·57	1·58	1·59	1·60	1·61	1·62	1·63
Number of specimens	1	1	...	...	1	...	1	...	...	1	...	...	...
Index . . .	1·64	1·65	1·66	1·67	1·68								
Number of specimens	...	...	...	...	1								

It will be seen that the amplitude of the index L/H is rather a large one, extending from 1·25 to 1·68, but the chain exhibits frequent and sometimes large gaps. I am, however, convinced that they are chiefly due to insufficient material; disregarding these gaps, the mathematical average of the index would be 1·465, and the average calculated from actual figures 1·443; the latter is therefore slightly smaller than the former, but contrary to observations, made in other species, the majority of specimens does not group around either of them; the variation formula is therefore—

$$\text{var. } 44 \begin{array}{c} 1{\cdot}68 \\ | \\ 1{\cdot}25 \end{array} \text{ average } \begin{cases} 1{\cdot}465 \text{ math.} \\ 1{\cdot}443 \text{ cal.} \end{cases}$$

(*b*) *Left valve.*—The same observation with regard to the younger and full-grown valves seems to hold good for the left valve too, though it may be probable that young specimens are a little less elongate than full-grown ones; if the indices are arranged in ascending order the following table is obtained:—

Index . . .	1·42	1·43	1·44	1·45	1·46	1·47	1·48	1·49	1·50	1·51	1·52	1·53	1·54	1·55
Number of specimens	2	1	...	...	...	...	...	...	1	...	...	1	1	1
Index . . .	1·56	1·57	1·58	1·59	1·60	1·61	1·62	1·63	1·64	1·65	1·66	1·67		1·68
Number of specimens	3	...	...	...	1	1	...	...	2	1	...	...		...
Index . . .	1·69	1·70	1·71	1·72	1·73	1·74	1·75	1·76	1·77	1·78	1·79	1·80		1·81
Number of specimens	...	1	...	...	...	...	1	...	...	...	...	...	...	1

So far as can be judged from these figures, which owing to the large and frequent gaps might be considered as not sufficient to draw any conclusions from the amplitude, the index L/H is a large one, ranging from 1·42 to 1·81; the mathematical average would therefore be 1·605 and calculated one 1·582, the former being as in

the case of the right valve slightly larger. The formula of variation would therefore be—

$$\text{var. } 40 \; \begin{array}{c} 1{\cdot}81 \\ | \\ 1{\cdot}42 \end{array} \; \text{average} \left\{ \begin{array}{l} 1{\cdot}605 \text{ math.} \\ \\ 1{\cdot}582 \text{ cal.} \end{array} \right.$$

Now if both formulæ are compared some remarkable features are revealed which in my opinion are not merely accidental. In the first instance we see that the amplitude of variation is nearly the same in both valves being var. 44 and var. 40 respectively; it is further unquestionably that in the right valve the amplitude includes smaller indices than in the left valve; in other words, the *left valve of this species is generally more elongate than the right one*, the average indices being—

$$\left\{ \begin{array}{l} 1{\cdot}465 \\ 1{\cdot}443 \end{array} \right. \text{ for the right and } \left\{ \begin{array}{l} 1{\cdot}605 \\ 1{\cdot}582 \end{array} \right. \text{ for the left valve,}$$

a feature which is not so easily noticed by the eye only.

On the basis of the above figures, if both valves are considered together the formula of variation would be—

$$\text{var. } 57 \; \begin{array}{c} 1{\cdot}81 \\ | \\ 1{\cdot}25 \end{array} \; \text{average} \left\{ \begin{array}{l} 1{\cdot}530 \text{ math.} \\ \\ 1{\cdot}502 \text{ cal.} \end{array} \right.$$

The species would, therefore, have a very large amplitude of variation, but it may be questioned whether it is justifiable to combine the variations of both valves considering that both are different in shape.

It will therefore be well to continue the plan of describing each valve separately.

(*a*) *Right valve.*—The valve is very strongly inflated; in ventral direction it is so much inflected, that it nearly becomes globular. The umbo is very low, depressed slightly, prosogyric, situated in front of the middle; it is very inequilateral, the pedal region being short and rounded, the siphonal region produced but obliquely truncated.

The anterior margin is rounded and passes gradually into the long convex ventral margin, which forms a sharp pointed angle with the short, straight but oblique posterior margin. The cardinal margin is long, angularly broken; its anterior portion which is the shorter passing gradually into the anterior margin, while the posterior portion forms an obtuse angle with the posterior margin. A strong sharp keel runs from the umbo towards the posterior corner, on its dorsal side the surface is steeply inclined, but slightly concave by a sharp furrow which runs from the umbo towards the middle of the posterior margin.

On the anterior region of the shell, *i.e.*, in front of the keel, the ornamentation consists of strong rounded concentric ribs, separated by deeply engraved linear interstices. The ribs are a little irregular as regards strength; on the umbonal region they are rather thin, but increase in strength rapidly, becoming at the same time somewhat undulating, particularly towards the ventral margin.

The region behind the keel is provided with fine concentric striæ only, instead of concentric ribs.

The hinge consists of a strong hook-like tooth underneath the umbo, C1, behind which there is a deep triangular slit; there is a rudimentary elongate posterior lateral LpI; there is also a very rudimentary LaI.

The muscular scars are deeply sunk, the posterior being the larger one, round, and anteriorly bordered by a strong ridge. The anterior scar is oval, set on a ledge; the pallial impression is strongly marked, not sinuated, rather distant from the margin.

(*b*) *Left valve.*—The valve is much less inflated than the right valve, and also less incurvated in ventral direction, but the ventral margin affords a peculiarity inasmuch as its edge is bent inwards at a right angle, forming a kind of ledge which rests in a groove of the right valve.

The other features are the same as in the right valve, except that the ribs are generally weaker, but in addition to the concentric ribs, there are radiating striæ increasing in strength posteriorly, which, however, are only visible on some specimens.

There is a deep ligamental socket having in front of it a rudimentary hardly visible C2a; LpII is thorn-like, moderately strong; internal characters the same as in the right valve.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Zone of *Parallelipipedum prototortuosum*, Kama.

Zone of *Pholas orientalis*, Thayetmyo.

Remarks.—*Corbula socialis* is so closely related to *Corbula prototruncata*, that I first considered them as identical, and in fact if only the right valves were known, the distinction of both species would be exceedingly difficult. Only on close comparison of well preserved specimens one would see that *Corbula prototruncata* is a little stouter so to speak, or to use the more scientific term the index L/H is generally much smaller in the right valve of *Corbula socialis* than in *Corbula prototruncata*. The chief difference rests, however, in the ornamentation of the left valve, which is nearly the same as that of the right one in *Corbula socialis* in addition to being nearly of the same size, while the surface is smooth, and the valve much smaller than the right one of *Corbula prototruncata*.

There is no doubt that the fossil here described is identical with *Corbula socialis*, Martin, from Java. Martin states that the ventral margin of both valves is inflated, a statement which I venture to question however; in fact the left figure of Martin's figure 10c., which shows the internal side of the right valve, shows distinctly the same sharp line which marks the boundary up to which the inflated ventral margin of the left valve reaches, as in the specimens here described, a line which cannot be confounded with the pallial impression. Moreover, the posteriorly increasing breadth ot this band is well depicted in Martin's figure.

The nearest living relative is *Corbula crassa* from the Andaman Islands; in fact the similarity between the Miocene *Corbula socialis* and the living *Corbula*

crassa is so great that both species might perhaps be considered as identical, if the same distinguishing features which had been noticed in other species were not observed with regard to these two; the living species apparently attains a larger size and the shell a greater thickness, but otherwise it is exactly the same as that of *Corbula socialis*; young specimens of *Corbula crassa* must be perfectly identical with *Corbula socialis*, and it is quite obvious that the living species is the direct descendant of the Miocene *Corbula socialis*.

CORBULA RUGOSA, Sowerby, Pl. XVI, figs. 8, 8*a*, 9, 9*a*, 10, 10*a*.

1840. *Corbula rugosa*, J. de Carle Sowerby, Trans. Geol. Soc. of London, New series, Vol. V, pl. XXV, fig. 5.

MEASUREMENTS.

(*a*) Right valve.

	Length.	Height.	L/H.
(1)	10·2 mm.	7·1 mm.	1·45
(2)	9·2 „	6·3 „	1·46

(*b*) Left valve.

	Length.	Height.	L/H.
(1)	8·0 mm.	5·1 mm.	1·56

The shell is of small size, very nearly equivalve, the left valve being slightly smaller that the right one.

(*a*) *Right valve.*—The right valve is transversely rhomboidal in shape, the length being somewhat in excess of the height, the index L/H is apparently not very high, and the valve is not very inequilateral.

The umbo is depressed, somewhat flattened and prosogyric, situated slightly in front of the middle line.

The pedal region is short, broadly acuminated, the siphonal region a little longer expanded but truncated.

The anterior margin is rounded and passes gradually into the straight, only slightly convex ventral margin which forms a sharp angle of about 60° with the straight and oblique posterior margin. Cardinal margin rather long, the anterior portion is ventrally inclined and passes gradually into the anterior margin, the posterior portion is straight, nearly parallel to the ventral margin, forming a very obtuse angle with the posterior margin.

A sharp, straight, slightly rounded keel runs from the umbo towards the posterior corner; the area behind it is moderately inclined and slightly concave.

During the nealogic stage the surface in front of the keel is smooth and exhibits only a few fine concentric striæ extending over the whole of the surface, including the posterior area, as can be judged from the ornamentation of the umbonal region. After the shell has reached a height of about 3 to 4 mm., concentric angular ribs of considerable strength appear suddenly, terminating abruptly at the posterior keel; the ribs, which are equidistant, are separated by broad concave interstices; the posterior area exhibits only a few fine concentric lines.

Characters of the hinge and internal features not known.

(*b*) *Left valve.*—The left valve which as already stated is slightly smaller than the right one, is of exactly the same shape as the former; the only difference which seems to exist, lies in the ornamentation, inasmuch as the greater part of

the surface is covered with fine concentric lines, while the strong ribs only appear close to the ventral margin.

Characters of the hinge and internal features not known.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.

Zone of *Meiocardia metavulgaris*, Singu.

Remarks.—General shape and ornamentation agree so well with Sowerby's *Corbula rugosa* from Sind, that although his figure is somewhat defective, I have no doubt that the specimens from Burma are identical with those from Sind. I am, however, not in the position to say whether *Corbula rugosa*, Sow., and *Corbula rugosa*, Lam., are really identical. Reeve does not mention a *Corbula rugosa*, Lam., and I cannot suppress some doubts as to the correctness of James de Carle Sowerby's determination; in fact I rather feel inclined to think that both species are not identical, a question which cannot, however, be settled yet. If my view should eventually prove to be correct, it must be understood that the specimens from Burma are identical with *Corbula rugosa*, Sowerby, but not with *Corbula rugosa*, Lamarck.

Corbula rugosa, Sow., is easily distinguished by its small size, its more or less rhomboidal shape, but particularly by its ornamentation as none of the other species exhibit similar angular ribs.

Among fossil species the nearest relative is *Corbula acuticosta*, Mart., from the Miocene of Java; in fact I believed at first that the two specimens were identical, but on closer examination some differences were noticed, which justify a specific separation. In *Corbula acuticosta* the strong concentric ribs extend from the umbo in ventral direction all over the anterior part of the surface; in *Corbula rugosa* they do not appear, but for some distance from the umbo; the shell was therefore more or less smooth during the nealogic stage, while it was concentrically ribbed during the same period in *Corbula acuticosta*.

Martin further mentions that in *Corbula acuticosta* the ribs terminate in very characteristic nodules on the posterior keel, a feature which is not exhibited by any of the species examined by me; it must, however, be remarked that in none of them this particular part of the test was preserved and that therefore the non-observation of this character does not prove its non-existence.

A much more important difference would be found in the ornamentation of the left valve. In *Corbula acuticosta* the ornamentation of the left valve exhibits strong ribs, while those of the right are much weaker; it is, however, difficult to judge with some accuracy about this character, because Martin figures only a right valve, and as this exhibits strong ribs all over the surface, those of the left valve must be very thick indeed, and the appearance of the left valve would therefore considerably differ from that of the same valve of *Corbula rugosa*, Sow.

Taking everything into consideration it cannot be denied that there exists a close relationship between the two species, although differences had to be recorded which render a specific identification impossible.

I cannot find any living relatives, as those species like *Corbula modesta* of the Indian Ocean have a strongly ribbed left valve, a feature which is not developed in

Corbula rugosa. This species represents therefore a type extinct among the fauna of the Indian Ocean.

CORBULA PROTOTRUNCATA, spec. nov., Pl. XVI, figs. 6, *a-e*, 7, *a-d*.

1895. *Corbula harpa*, Noetl., Miocene Foss. of Upper Burma, Mem. Geolog. Survey of India, Vol. XXVII, Pt. 1, pl. V, fig. 8, *a-e*.

MEASUREMENTS.

Length.	Height.	L/H.
14·0 mm.	10·3 mm.	1·35

Though of rather frequent occurrence in some beds, well preserved specimens are rare, so that I succeeded in getting the measurements of a single right valve only.

The shell is rather inequivalve, the right valve being much larger than the left one, in addition to it being differently ornamented.

(*a*) *Right valve.*—The right valve is triangular in shape, and as there is generally only a small difference between the length and height, the index L/H is apparently only small and the valve affords a peculiar short, antero-posteriorly compressed shape; it is rather strongly inflated but a little flattened towards the umbonal region.

The umbo is low, pointed, prosogyric, and strongly incurvated, situated slightly in front of the middle line.

The shell is very inequilateral, the pedal region being short, rounded, the siphonal region short, attenuated and obliquely truncated.

The anterior margin is short, rounded, passing gradually into the broadly convex ventral margin; the posterior margin is oblique, very short and forms a sharp pointed angle with the ventral, and a slightly obtuse angle with the cardinal margin. Cardinal margin long, curved; the anterior portion, which is the shorter, passes gradually into the anterior margin, while the somewhat longer, posterior portion forms a sharp angle with the posterior margin.

A sharp sinuated keel runs from the umbo towards the posterior corner, separating a narrow posterior area from the larger anterior region; the posterior area which drops nearly perpendicularly, is slightly concave, and bears a deep and sharp furrow, which runs from the umbo towards the middle of the posterior margin. The ornamentation consists of concentric rounded ribs, which quickly increase in strength towards the ventral margin; at the umbonal part of the shell the ribs are straight, but very soon they become strongly bent in ventral direction, owing to the curvature of the shell; the ribs terminate suddenly at the keel, and on the posterior area only numerous fine concentric striæ are visible. The interstices are nearly as broad as the ribs and rather deep.

The hinge consists of a very strong, hook-like tooth, C1, which is strongly curved upwards; there are no signs of any laterals. The muscular scars are well marked; the posterior, which is the larger one, is round, the anterior, which is a little smaller, is oval. Pallial impression strongly marked; there is, however, no sign of a sinus.

(*b*) *Left valve.*—While right valves were rather frequent, only a single left valve has come under examination, and even this is very poorly preserved. All that can be said is, that it was much smaller than the right valve, triangular in shape, the pedal region very short and rounded, the siphonal a little longer but attenuated. So far as can be judged from this single specimen, the surface was perfectly smooth, except some fine striæ of growth.

Geological occurrence.—

Zone of *Dione dubiosa*, Yenangyat.
Zone of *Paracyathus caeruleus*, Yenangyat.
Zone of *Arca theobaldi*, Kama.

Remarks.—Misled by Messrs. d'Archiac and Haime's figure I originally believed this species to be identical with *Corbula harpa*, but I have since convinced myself that this species which occurs in the *Cardita beaumonti*-bed of Upper Cretaceous age is different from the species here under examination. Mr. Fedden had already stated that *Corbula harpa* was restricted to the Ranikhot and Upper Cretaceous beds, but considering the great confusion with regard to the geological horizon of the fossils described by Messrs. d'Archiac and Haime, I did not repudiate the possibility of *Corbula harpa* occurring perhaps in higher Tertiary beds. As I have since had an opportunity of examining the true *Corbula harpa*, I may safely say that this species is limited to the above-mentioned beds.

The specific determination of this species afforded great difficulties; in the first instance the right valve bears a great similarity to *Corbula socialis*, Mart., a similarity which is so great, that only with difficulty both specimens can be separated when isolated right valves are examined. In fact, it is nearly impossible to distinguish var. 1·25 to 1·35 of *Corbula socialis* from specimens of *Corbula prototruncata* having a similar index. It may perhaps be said that the ribs of *Corbula prototruncata* are a little coarser, a feature which is, however, very deceptive.

As, however, the left valves of both species are widely different with regard to general shape and ornamentation, it is obvious that the two species are different.

Professor Martin has described from the Miocene of Java under the name of *Corbula scaphoides*, Hinds, a species which bears such a great likeness to the Burma species that I first was inclined to consider them as identical, but for the following reasons: (1) *Corbula scaphoides*, Mart., seems to be bigger. (2) In *Corbula scaphoides*, Mart., the umbonal region of the left valve shows concentric ribs, a feature which is certainly not observed in the specimens from Burma.

Professor Martin states, however, that the *right* valve of *Corbula scaphoides* sometimes becomes perfectly smooth (see fig. 199). May not the same apply to the left valve also? If this be the case, and if specimens of *Corbula prototruncata* were found which exhibit concentric ribs towards the umbonal region of the left valve, this species should be considered as identical with *Corbula scaphoides*, Martin.

I cannot, however, agree with Prof. Martin, who identifies the species described by him with *Corbula scaphoides*, Hinds; the figure which Reeve gives of this species differs so widely from that of Prof. Martin, that, notwithstanding the somewhat

crude picture of the former species as given by Reeve, the difference is at once obvious. In addition to this Reeve states distinctly: "interstices cancellated with minute longitudinal striæ." So prominent a feature could hardly be overlooked by such a careful examiner as Prof. Martin, and I venture to believe that the living specimen of *Corbula scaphoides* from Hongkong which Prof. Martin examined was not identical with Hinds' species.

Another species, which appears to be closely related, is *Corbula semitorta*, Bœttg., from the Lower Miocene of Java, but unfortunately only the right valve of this species is known, and unless it is proved that the left valve of *Corbula semitorta* is smooth like that of *Corbula prototruncata*, it is perhaps better to keep both species separate. If the above assumption should, however, prove to be correct, the specific name *prototruncata*, Noetling, should be substituted by *semitorta*, Bœttger.

Among the living species *Corbula truncata*, Reeve, from the Andaman Islands is so close a relative that I first considered both species as identical: on comparison I found, however, some differences with regard to the sculpture of the left valve, which though very insignificant could not be disregarded.

In *Corbula prototruncata* the left valve appears to be smooth; in *Corbula truncata* the umbonal region of the left valve is smooth, and after a certain height has been reached, concentric ribs, like those on the right valve, make their appearance; they continue for some time, till the shell has reached a height of about 6 mm. and then suddenly discontinue, being replaced by an irregular sort of fibrous ornamentation; in fact it seems as if the ventral portion of the left valve consisted chiefly of laminous layers of epidermis.

It is therefore quite certain that the nealogic stage of *Corbula truncata* is identical with the Miocene *Corbula prototruncata* and that the former is a direct descendant of the latter, the left valve having evolved some characters which were not developed in that of the Miocene species.

Family: *PHOLIDÆ*, Leach.

Genus: PHOLAS, Linné.

Two species have been described which can be easily distinguished as follows:—

A. Shell almost closed, not sinuated at the anterior margin.
    1. *Pholas orientalis*, Gmelin.

B. Shell widely gaping and deeply sinuated at the anterior margin.
    2. *Pholas blanfordianus*, spec. nov.

The first-named species is identical with the species of the same name inhabiting the Indian Ocean, while *Pholas blanfordianus* represents an extinct type which has its nearest living relative in *Pholas manillæ*, Sow., from the Philippine Islands.

Pholas orientalis, Gmelin, Pl. XVI, figs. 11, 11*a*, 12, 12*a*.

1872. *Pholas orientalis*, Reeve, Monograph of the Genus *Pholas*, Pl. II, figs. 6, *a*-*b*.

Measurements.

	Length.	Height.	L/H.
Right valve	53·1 mm.	16·3 mm.	3·25
Left valve	54·8 „	19·6 „	2·80

The shell is very transversely elongate, triangular in shape, the length exceeds the height to such an extent that the index L/H exceeds 3; unfortunately the specimens are seldom well preserved, therefore the measurements of two specimens only could be taken; it is equivalve, moderately inflated and very inequilateral.

The umbo is somewhat inflated, but strongly incurvated and situated much in front of the middle line. The pedal region is short, accuminate, the siphonal region extremely elongate, strongly accuminate.

The anterior margin is short, rounded, passing gradually into the long, slightly convex ventral margin; the posterior margin is short, rounded, passing gradually into both ventral and cardinal margin; the latter is very long, angularly broken, inequilateral; the posterior portion is straight, strongly ventrally inclined and much longer than the anterior portion; the latter is very short, slightly concave and somewhat steeper inclined in ventral direction. The shell was apparently anteriorly open.

The ornamentation consists of about 25 to 27 imbricated radiating ribs, which cover, however, only a little over the anterior half of the shell. The posterior part of the shell is apparently smooth, except for numerous closely set concentric striæ of growth, but seen under a magnifying lens it will be noticed that it is covered with countless minute granules producing a kind of chagrin-like appearance.

Internal characters and dorsal valves not observed. Test very thin measuring not more than 0·27 mm. in thickness.

Geological occurrence.—

Zone of *Pholas orientalis*, Thayetmyo.

Remarks.—It may seem venturesome to identify this species with a recent one, without the dorsal valves being known, as the specific determination of the Pholadidæ depends so much on this character. I have, however, convinced myself from comparison with the living species that the Miocene specimens can in no way be distinguished from *Pholas orientalis*, Gem., inhabiting the Indian Ocean.

No species of *Pholas* has been known from the Sumatra, Java or Western India Tertiary formation.

Pholas blanfordianus, spec. nov., Pl. XVI, figs. 13, 13*a*, 14, 14*a*.

Measurements.

	Length.	Height.	L/H.
Left valve	52·0 mm.	20·2 mm.	2·57.

The shell is elongately wedge-shaped, considerably longer than high, the index

L/H is therefore rather high; it is strongly inflated and very inequilateral, anteriorly gaping.

The umbo is low, depressed, situated rather close to the anterior margin.

Pedal region short, accuminated, siphonal region very elongate, slightly accuminated, truncated. The anterior margin which forms a sharp pointed angle with the cardinal margin is short, deeply sinuated and forms an obtuse angle with the long almost straight ventral margin; posterior margin short, rounded, cardinal margin long, angularly broken, the anterior part very short, the posterior part long and ventrally inclined.

A deep, narrow furrow runs from the umbo parallel to the anterior portion of the cardinal margin, towards the junction of cardinal and anterior margin.

Almost the whole surface of the shell, except its hindmost portion, is covered with fine, nodose radiating ribs separated by broad flat interstices; besides the ribs there are numerous, somewhat irregular striæ of growth, which, in concordance with the anterior gaping of the shell, are strongly bent in dorsal direction on the siphonal region.

Dorsal valves, character of the hinge and internal features not observed.

Geological occurrence.—

Zone of ***Pholas orientalis***, Thayetmyo.

Remarks.—This species is easily distinguished from ***Pholas orientalis*** by its widely gaping pedal region, a deeply sinuated anterior margin and a deeply excavated surface below the anterior part of the cardinal margin.

Among the living species, ***Pholas manillæ***, Sow., from the Philippine Islands seems to be a very close relative; the general shape, the deeply sinuated pedal region, being excavated towards the cardinal margin, are features which are well represented in ***Pholas manillæ***; having, however, no specimens of this species for comparison, I must refrain from drawing further conclusions.

2. Class: GLOSSOPHORA, Fischer.

1. Sub-class: SCAPHOPODA, Bronn.

Order: SOLENOCONCHÆ, Lacaze Duthiers.

Genus: DENTALIUM, Linné.

Two species of this genus, which are easily distinguishable from each other, have come under examination. Though both are only preserved in fragments it seems almost certain that they were not provided with a fissure at the posterior end.

The two species can be distinguished as follows:—

A. Shell of large size, longitudinal ribs numerous, not less than 25.
 1. *Dentalium junghuhni*, K. Martin.

B. Shell of small size, longitudinal ribs few, not more than 16.
 2. *Dentalium böttgeri*, spec. nov.

Dentalium junghuhni is identical with *Dentalium magnificum* from the Indian Ocean, while no living or fossil relative of *Dentalium bœttgeri* could be discovered.

DENTALIUM JUNGHUHNI, K. Martin, Pl. XVII, figs. 1, *a-b*, 2, 3, *a-b*.

1879-80. *Dentalium junghuhni*, K. Martin, Tertiärsch. auf Java, p. 87, pl. XII, fig. 11.
1883. „ Bœttger, Die Tertiärform. von Sumatra, Palæontogr. Suppl., Vol. III, p. 141, pl. XII, figs. 6, *a-d*, 8 (non 7).
1883-87. „ K. Martin, Tiefbohr. auf Java. Beitr. zur Geol. Ost. Asiens und Australiens, 1st ser., Vol. III, p. 185, pl. X, figs. 182, 183.

No complete specimen is preserved, but to judge from the largest fragment which measures 31 mm. in length and 5 mm. in diameter at the upper end the shell must have attained a considerable length. It appears that it is very slightly curved, almost straight, the section being rounded at the upper, but distinctly hexagonal at the lower end. The surface is covered with strong longitudinal ribs of which there appear to be six primary ones; on the flat interstices finer ribs begin to appear which soon reach the strength of the primary ones; at the same time the angular section changes gradually into a round one, and the largest fragment which is perfectly cylindrical, bears about 25 strong rounded longitudinal ribs, while in the interstices finer ones are visible. The longitudinal ribs are crossed by numerous closely set striæ of growth.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.

Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—The larger size and the larger number of longitudinal ribs readily distinguish this species from *Dentalium bœttgeri*. The characters of the species here described are essentially the same as those of *Dentalium junghuhni* as figured and described by K. Martin. As the posterior part of the shell was apparently not known to Martin, he could not therefore observe the gradual change in the ornamentation as above described.

Dentalium subrectum, K. Martin, from Java seems so closely related to *Dentalium junghuhni* that it is doubtful to me whether a specific separation is justified. In fact the type of *Dentalium junghuhni* [1] seems to me much nearer related to the type of *Dentalium subrectum* than to *Dentalium junghuhni* figured and described in the same paper [2] with the original of *Dentalium junghuhni*.

Bœttger was apparently mistaken in considering the small specimen fig. 7 as the posterior part of *Dentalium junghuhni*, as this species never exhibits eight but only six primary ribs. I believe Bœttger's fig. 7 to be identical with a new species which I described on the following pages as *Dentalium bœttgeri*.

Having been able to compare *Dentalium magnificum* from the Indian Ocean I can state with certainty that it is absolutely identical with the species here described, and as I consider this identical with *Dentalium junghuhni*, this name ought to supercede the more recent one of "*magnificum*."

[1] Tertiar. auf Java, pl. XII, fig. 11.
[2] Tiefbohr. auf Java, pl. X, figs. 182, 183.

DENTALIUM BŒTTGERI, spec. nov., Pl. XVII, fig. 4, *a-b*.

Only fragments of this species have come under examination; the largest measures about 10 mm. in length, and 2·3 mm. in diameter at the upper end. The shell which does not seem to have attained a large size is slightly curved, angular at the posterior, and circular at the anterior end; its thickness decreases at the same time towards the anterior margin which is sharp and cutting. The surface bears 8 rounded, strong longitudinal ribs, separated by flat interstices of equal breadth in which a secondary rib makes its appearance at about half the length of the shell attaining the strength of the primary ribs towards the margin.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Remarks.—This species is easily distinguished from *Dentalium junghuhni* by its smaller size and the smaller number of ribs towards the anterior end, the difference in the character of the ornamentation may be expressed in a few words: in *Dentalium bœttgeri* there are a larger number of primary ribs (8) than in *Dentalium junghuhni* where there are only six, but in the latter species there are a larger number of secondary ribs in the interstices, four to five, while in the former there is only one. *Dentalium bœttgeri* which bears a great resemblance to *Dentalium heptagonum*, Bœttger, as described by K. Martin,[1] may perhaps be identical with this species inasmuch as it exhibits eight longitudinal ribs, but as the other character of *Dentalium octagonum*, the appearance of one secondary rib in the interstices, is neither figured nor mentioned by K. Martin, the specific identity may be doubtful.

Dentalium octagonum is certainly different from the type of *Dentalium heptagonum*, Bœttger, which is characterised by seven primary ribs, the interstices of which remain smooth without any secondary ribs making their appearance.

On the other hand, it seems to me that in the description of *Dentalium junghuhni*, Bœttger has mixed up two different species by considering the fragment fig. 7 as the anterior end of that species; this fragment agrees perfectly in regard to its ornamentation with *Dentalium bœttgeri* from Burma, while the posterior end of *Dentalium junghuhni*, as observed by me in specimens which unquestionably belong to this species, never shows eight but only six primary ribs.

A comparison with living species seems almost out of question unless the species can be actually compared and examined. Reeve's figures and descriptions, though perhaps sufficient for the Conchyologist, are very unsatisfactory for palæontological purposes. It seems to me, however, that *Dentalium pseudohexagonum*, Des., from Java is closely related to *Dentalium bœttgeri*. In fact if there were instead of six primary ribs as indicated by the name, eight as indicated by the figure, the Miocene species should be considered identical with the living *Dentalium pseudohexagonum*.

Dentalium javanum is another species which at the first glance might be mistaken for *Dentalium bœttgeri*, having also eight primary ribs like that species;

[1] Tiefbohr. auf Java, p. 188, pl. X, fig. 88.

but in *Dentalium bœttgeri* a secondary rib arises in each of the interstices between the primary ribs, while in *Dentalium javanum* they remain smooth.

Taking everything into consideration I believe that *Dentalium bœttgeri* represents a type which is extinct among the present fauna of the Indian Ocean.

2. Sub-class: GASTROPODA, Cuvier.

Order: PROSOBRANCHIA, Milne Edwards.

Sub-order: ASPIDOBRANCHIA, Cuvier.

Family: *TROCHIDÆ*, d'Orbigny.

Genus: TROCHUS, Linné.

The sub-division of the old genus Trochus into a number of sub-genera, taking almost the rank of genera, is certainly justified, when we consider the large number of widely different species formerly composing it. On the other hand, it may well be asked whether this sub-division is of any benefit to the palæontologist, who, in very rare instances, will have sufficiently well preserved specimens to decide with certainty to which sub-genus a certain species may belong. Yet the incongruity of uniting even the small number of species here described under the same generic name is too obvious, considering that they have no other feature in common but a conical shell, and I dare say the same difficulty has been met with by anybody describing a larger number of *Trochi*.

Though hampered by a good many disadvantages the adoption of sub-genera or genera into which *Trochus* has been divided, can hardly be avoided, particularly if one has to deal with a fauna which bears such close relationship to a recent one as the Miocene fauna of Burma does.

On the following pages five species have been described, one of which is too ill-preserved to allow even for a specific determination, though it is quite certain that it does not belong to any of the sub-genera mentioned below. The other four species represent three sub-genera, *viz.*:—

Calliostoma, Swainson.
Basilissa, Watson.
Turcica, H. and A. Adams.

Only *Calliostoma* is represented by more than one species, *C. blanfordi* and *C. kœnenianum*, both species which are, however, so widely different, that it would perhaps be better to distinguish them under different sub-genera names.

The most remarkable feature of these five species is that they apparently represent types which are extinct among the fauna of the Indian Ocean. I studied and compared with the greatest care the *Trochi* in the Indian Museum, yet I have not been able to discover a single species to which any of the fossil ones could be compared. The only living species bearing a relationship to a fossil

one is *Turcica monilifera*, H. and A. Adams, from Australia, while the sub-genus *Basilissa* seems at present restricted to the Japanese seas, the Pacific and Atlantic Ocean.

It is, therefore, almost certain that the five species here described represent types which are extinct in the present fauna of the Indian Ocean. If we omit the specifically undetermined one, two species, *viz.*, *Calliostoma blanfordi* and *Calliostoma kœnenianum*, have no living relatives at all. Both probably represent indigenous types, the next relatives of which may occur in the Indian Eocene.

Of the other two species, *Basilissa loriolians* and *Turcica protomonilifera*, the latter has a living relative in *Turcica monilifera*, inhabiting at present the Australian seas, while no living representative is known of the former. In a fossil state *Basilissa* occurs, however, in the Eocene of Paris. It seems therefore remarkable that the relatives of these two species should inhabit at present the Australo-Japanese seas, while on the other hand there is an unquestionable connection with the Eocene of Paris indicated by the existence of the genus *Basilissa*.

1. Sub-genus: CALLIOSTOMA, Swainson.

CALLIOSTOMA BLANFORDI, Noetling, Pl. XVII, figs. 5, 6, 6*a*, 7, 7*a*, 8, *a-c*.

1895. *Trochus blanfordi*, Noetling, Mar. Foss. from Mioc. of Upper Burma, Mem. Geolog. Survey of India, Vol. XXVII, pt. 1, p. 16, pl. IV, figs. 1, 2*a*.

MEASUREMENTS.

Height .	17·5. mm.
Width .	19·5. „
Spiral angle	69°

The regularly conical shell is of comparatively small size as none of the specimens attain a larger height than 19 mm. As the whorls are almost flat, the sides form nearly a straight line.

Embryonic whorls not observed.

There are at least six spire whorls, very gradually increasing in height which are separated by a fine, though not easily distinguishable suture; the posterior two-thirds of the whorls are slightly concave, the anterior one flat. The ornaments consist of 4 tuberculated, spiral keels; and counting in posterior direction No. 2 is the strongest of all, while No. 1 is stronger than 3 and 4; there is also a difference with regard to the size of the tubercles; those of No. 1 are smallest and very closely set, those of No. 2 are a little larger but also closely set, while those of Nos. 3 and 4 are fairly large and separated by broad interstices. The body whorl is similar to the spire whorl from which it seems to differ in no way.

The base is flat, even slightly concave and separated by a sharp angle from the upper part of the body whorl; it exhibits a rather small, false umbilicus, and its ornamentations consist of about a dozen tuberculated spiral lines, which are apparently arranged in such a way, that finer and coarser ones regularly alternate.

Aperture not observed.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Meiocardia metavulgaris*, Singu.
Zone of *Cancellaria martiniana*, Minbu.
Zone of *Paracyathus caeruleus*, Yenangyat.

Remarks.—This species is easily distinguished by its ornamentation consisting of tuberculated spiral keels, two of which situated in the anterior third of the whorls are considerably stronger than the others.

Well preserved specimens are, however, rare, and only under very fortunate circumstances the tuberculated character of the spiral keels has been preserved; the superficial layer of the shell easily peals off, and the keels appear then perfectly smooth. I am therefore not quite certain with regard to the ornamentation of the body whorl; it appears that the number of spiral keels increases on the body whorl; at least a specimen from Yenangyat distinctly shows a larger number than four; but on others from Singu only four distinct keels are visible.

In my previous memoir I considered the living *Clanculus scabrosus* a close relative of this species, but having obtained better preserved specimens of *Calliostoma blanfordi* which allowed for a better comparison, this view seems untenable.

Clanculus scabrosus is, if we disregard the characters of the aperture, distinguished by a shorter, more inflated shell, a longitudinal section of which would show a rather large angle with convex sides. In *Calliostoma blanfordi* we have a more elongate, accuminate shell, the longitudinal section of which shows a small angle with concave sides. In addition to the shape, the ornamentation exhibits also considerable differences; in *Clanculus scabrosus* there are a few, coarsely granulose revolving keels, while in *Calliostoma blanfordi* the keels are numerous and very neatly and regularly granulose.

No similar species has been described from Java, Sumatra or Western India, and though I have devoted great care to the study of the *Trochi* in the collection of the Indian Museum, I could not discover any species to which *Calliostoma blanfordi* could be compared; it seems therefore certain that it represents an extinct type. Whether similar species will be found in the older Tertiary beds of India remains to be seen; but the probability that *Calliostoma blanfordi* represents an indigenous type is by no means small.

CALLIOSTOMA KOENENIANUM, spec. nov., Pl. XVII, figs. 14, *a-b*, 15, 15*a*.

MEASUREMENTS.

Height	8 mm.
Width	7 „
Spiral angle	52°

The shell is of small size, regularly conical in shape and consists of about 10 low whorls which very slowly increase in height.

The embryonic whorls, apparently two in number, are perfectly smooth.

The spire whorls are six in number and their aggregate height is about half of the total height; they are separated by an ill-defined suture. The ornamentation is of two kinds; on the three or four oldest ones, those succeeding immediately to the embryonic whorls, it consists of four granulated spiral keels, these granulations gradually disappear, till the keels become perfectly smooth; keel No. 2 becomes considerably stronger than the others which remain of equal strength.

The body whorl which occupies about half the height is slightly concave on its posterior side and set with three primary and two secondary smooth spiral keels, the latter being intercalated between Nos. 3 and 4, No. 2 being as on the spire whorls considerably stronger than the others.

The base is slightly inflated towards the aperture and set with three flat smooth keels, separated by linear interstices along the periphery, and with two similar keels around the umbilicus, a broad smooth band remaining in the middle.

The aperture is small, the outer lip sharp, the inner lip callous.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Remarks.—This species is easily distinguished from all the others by its ornamentation; even if the earlier granulated spire whorls are not visible, the sharp, raised and smooth keels of the remaining spire whorls, as well as on the body whorl, are sufficient to distinguish it.

Turcica protomonilifera, particularly when it is slightly weathered, might perhaps be somewhat alike, but the strong keels on the base of the latter readily distinguish it. There is no species among the previously described ones either from India or Java or Sumatra to which this species could be compared, nor could I find any similar species among the fauna of the Indian Ocean, and the probability that *Calliostoma koenenianum* represents an extinct type is by no means small. Among the fossil species *Trochus sulcatus* from the Paris Eocene, Lamk., which has been included by Cossmann among the genus *Basilissa*, a view which, in consideration of the other species belonging to *Basilissa*, might perhaps be questioned, seems a near relative to *Calliostoma koenenianum*, but until the ornamentation of the earlier spire whorls of the species is known, no definite view can be expressed whether this relationship is really founded or only apparent.

2. Sub-genus: BASILISSA, Watson.

This genus represents a characteristic group of *Trochi*, which are distinguished by their sharply carinated whorls; the keel runs exactly along the ambitus and behind it the surface appears to be covered with fine revolving chords only. Cossmann has given some more distinguishing features with regard to aperture, etc., but only in rare cases can it be hoped to observe these characters in fossil species. It appears that *Basilissa* does not occur in the Indian Ocean and in a fossil state only in the Paris Eocene. Cossmann remarks, therefore, that

the existence of *Basilissa* "est un rapprochement de plus entre la faune actuelle du Japon et celle de l'Eocéne parisien."

The species here described as *Basilissa lorioliana* unquestionably belongs to this genus, and its existence in the Miocene of Burma is the more interesting, as it is another proof of the marked relationship of the Miocene fauna of Burma with that inhabiting at present the Eastern Seas. On the other hand it indicates those relations with the Eocene of Paris which are frequently met with.

BASILISSA LORIOLIANA, spec. nov., Pl. XVII, figs. 11, 12, 13, *a-c*.

MEASUREMENTS.

	(1)	(2)
Height .	6·5 mm. .	6·5 mm.
Width .	11·0 „ .	11·5 „
Spiral angle	90°	85°

The shell is of small size only, regularly conical in shape. The whorls are perfectly flat, the sides therefore quite straight.

Embryonic whorls not observed.

There are at least six whorls, five of which compose the spire and occupy a little less than half of the total height. They increase slowly and gradually in height and are separated by a sharp and deep suture. The profile of the surface forms a flat S-shaped curve, that is to say, its posterior part is very feebly inflated, while a distinct though shallow groove runs close to the anterior margin, setting off a sort of pseudo-keel. The whole surface is covered with about ten fine granosely plicate spiral lines of varying strength.

The body whorl differs in no way from the spire whorls, except that towards the aperture a few longitudinal lines of growth are visible.

The base is slightly inflated and covered with numerous fine granosely plicate spiral lines which are crossed by sharp, somewhat irregular, longitudinal striæ. The false umbilicus appears to be rather small : aperture only partly observed, proving that the outer lip was sharp.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.

Zone of *Meiocardia metavulgaris*, Singu.

Zone of *Arca theobaldi*, Kama.

Remarks.—This pretty species is easily distinguished from the other two species by its rather short, thickly set shape, and the uniform character of the granulose longitudinal lines, among which none preponderates in strength.

No similar species has been described either from Java, Sumatra or Western India, neither can I find a living relative among the fauna of the Indian Ocean. The probability that *Basillisa lorioliana* represents an extinct type is therefore very great.

Sub-genus: TURCICA, H. and A. Adams.

TURCICA PROTOMONILIFERA, spec. nov., Pl. XVII, figs. 9, *a-b*, 10, *a d*.

MEASUREMENTS.

Height	13 mm.	4·5 mm.
Width	10·5 „	3·6 „
Apical angle	69°	67°

The shell attains only a small size, but is of regularly conical shape, the flanks of the whorls being almost flat.

There are two embryonic whorls which seem to be perfectly smooth as no traces of ornamentation can be discovered even with a powerful magnifying lens.

There are four spire whorls which very slowly and gradually increase in height; their aggregate height is less than half of the total height, and they are separated by a very deep suture. On each whorl there are four granulated keels, No. 1 of which, close to the suture, is always the strongest; on the earlier whorls the keels are very closely set, but on the penultimate one they become further distant.

The body whorl occupies more than half of the total height and its ornamentation is exactly the same as those of the spire whorls, only that the keels become still further distant and are now separated by interstices larger than their own breadth; the granules are now well separated from each other by interstices of about 1½ their own breadth. Towards the aperture sharp, closely set plications become visible in the interstices between the keels.

The base is strongly inflated towards the aperture and set with four strongly raised granulated keels which are separated by broad, concave interstices, decreasing in breadth towards the centre. False umbilicus very small, slit like.

The aperture is not well observed, but it is distinctly seen that the columella is spirally twisted, ending anteriorly in an obtuse prominent point. The outer lip is unfortunately broken, but it was unquestionably sharp, rather thin and lined with about ten smooth revolving keels.

Geological occurrence.—

Zone of *Meiocardia metavulgaris*, Singu.

Zone of *Arca theobaldi*, Kama.

Remarks.—Only two specimens of this pretty species have come under examination, and if it had not been for the better preserved specimen from Kama, the specific characters could not have been made out to satisfaction, inasmuch as the specimen from Singu is so much weathered that the whole shell appears to be smooth, and only by means of the strong basal keel its identity with the specimen from Kama could be established.

The strong columellar fold, but particularly the internal keels of the outer lip, prove that this species must be related to *Turcica monilifera*, A. Adams, from Australia, which seems to be so similar in shape, ornamentation and the characters

of the aperture, that it is certain that the specimen under examination belongs to this genus. In fact the similarity seems so close, that I am not quite certain whether this species should not be identified with the living one—a question which can, however, only be settled by comparison with the living species.

TROCHUS, spec., Pl. XVII, figs. 16, 16a.

MEASUREMENTS.

Height	. 18·0 mm.
Width	. 19·5 "
Apical angle	. 70°

Only a single ill-preserved specimen of this species has come under examination, but the few characters that can be made out distinctly prove that it is different from the others here described.

The shell is of fairly large size, regularly conical and appears to consist of about seven rounded whorls, which are separated by a deep suture. The ornamentation consists of about twelve granulated revolving keels, which appear to be separated by narrow interstices. The body whorl occupies slightly more than one-third of the whole height, and bears the same ornamentation as the spire whorls. The base is slightly inflated and covered with about twelve granulated revolving keels of equal strength.

Geological occurrence.—

Zone of *Cytherea erycina*, Prome.

Remarks.—Though the above characters, in particular the rounded whorls, and the apparently uniform size of the granulated keels, are sufficient to distinguish this species readily from the others here described and prove it to be a different species, its preservation is not such as to justify a specific name, because it could never be distinguished from species of a similar character.

Under the name of *Trochus* (*Entrochus*) *jujubiniformis*, Martin described a species from Sumatra which seems closely related to the species under examination; the Sumatran species is, however, distinguished by a higher shell while that from Burma possesses a more depressed spire. In this regard it more resembles *Ziziphinus bicingulatus*, Lam., than any other species.

2. Sub-order: *CTENOBRANCHIA*, Schweigg.

1. Section: PTENOGLOSSA, Troschel.

Family: *SOLARIIDÆ*, Chenu.

Genus: SOLARIUM, Lamarck.

The five species described on the following pages belong to two, perhaps to three sub-genera, three of them, *viz.*, *Solarium nitens*, *Solarium maximum* and

Solarium coniforme, belong to *Solarium*, *s. s.*, while the other two belong to the sub-genus *Torinia*, Gray, though the position of *Torinia buddha* species is not quite certain.

These five species can be easily distinguished as follows :—

A. Whorls angular : *Solarium*, s. s.
- (a) Surface with 3 revolving keels.
  - 1. *Solarium nitens*, spec. nov.
- (b) Surface with 5 revolving keels.
  - 2. *Solarium maximum*, Philippi.
- (c) Surface with 18 revolving keels.
  - 3. *Solarium coniforme*, spec. nov.

B. Whorls rounded : *Torinia*.
- (a) All the whorls covered with granulose keels.
  - 4. *Torinia protodorsuosa*, spec. nov.
- (b) Only the body whorl covered with a few smooth revolving keels.
  - 5. *Torinia buddha*, spec. nov.

The relationship of these five species is rather peculiar; one of them, *Solarium maximum*, has, with the greatest certainty, been identified with the recent species of that name; *Torinia protodorsuosa* is so closely related to the living *Solarium dorsuosum* that it must be considered as its predecessor; *Solarium nitens* shows so great a similarity with *Solarium picteti*, Des., and *Solarium bistriatum*, Lmk., from the Eocene of Paris, that it is almost impossible to discover any difference; no relationship either with living or fossil species could be traced for *Solarium coniforme* and *Torinia buddha*.

1. Sub-genus: SOLARIUM, Lamarck, s. s.

SOLARIUM NITENS, spec. nov., Pl. XVII, figs. 18, 18*a*.

MEASUREMENTS.

Height . .	?
Width . .	13·0 mm.
Apical angle .	130°

Only a single specimen partly imbedded in the rock has come under examination. The shell is apparently of small size, depressed, conical in shape, and consists of not less than six flat angular whorls, separated by an ill-defined suture. The spire whorls increase very gradually and slowly in height; close to the anterior end runs a rounded revolving keel and separated by a very fine, though deeply engraved furrow runs another keel of about the same strength as No. 1. Close to the posterior end of the surface runs a fine furrow detaching a third rounded keel which is, however, weaker than No. 1 and No. 2. The broad band between keels Nos. 2 and 3 remains perfectly smooth, except that it is crossed by numerous, longitudinal striæ of growth, some of which become stronger than the others and seem to follow each other at regular intervals.

The body whorl differs in no way from the spire whorls, except that No. 1 keel which runs along the ambitus becomes much stronger than either No. 2 or No. 3.

Base not observed.

Geological occurrence.—

Zone of *Pholas orientalis*, Thayetmyo.

Remarks.—At the first glance this species might be easily mistaken for *Solarium maximum*, but on closer examination it will be seen that it is easily distinguished by the smooth whorls. The central band which in *Solarium maximum* carries two granulated keels is perfectly smooth in *Solarium nitens*, and in addition to this feature the revolving keels which are strongly granulated in *Solarium maximum* are smooth in *Solarium nitens.*

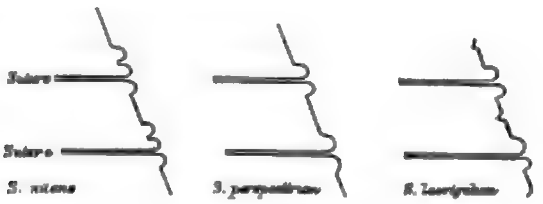
One would also feel inclined to consider the living *Solarium perspectivum*, of which I examined a specimen from the coast of Baluchistan, as a near relative of *Solarium nitens*, but on closer examination well marked differences will be noticed. I stated above that in a longitudinal section through two consecutive whorls it would appear as if three revolving keels were running parallel to the suture, two behind and one in front of it; if the same section is taken in *Solarium perspectivum*, it will be seen that there is only one keel on either side of the suture, a broad one on its anterior and a narrow one on its posterior side; these keels are further more crossed by longitudinal, sharply engraved furrows, which give them a granulated appearance; it is only on the body whorl that these furrows disappear, while they are still more pronounced on the earlier whorls, extending over the whole surface, including the broad central band, thus giving the earlier spire whorls a peculiar granulose appearance. Another species which would also appear closely related is *Solarium lævigatum;* this species is, however, easily distinguished by a sharply engraved revolving furrow running in the middle of the smooth central band which corresponds to the furrow separating keels Nos. 3 and 4 in *Solarium maximum;* the longitudinal section through two consecutive whorls shows the same feature as noticed in *Solarium perspectivum*, viz., only one keel on either side of the suture, a broad anterior and narrow posterior one. The earlier spire whorls are in the same way granulated as in *Solarium perspectivum* only in a less marked way. In *Solarium nitens*, on the other hand, they remain perfectly smooth.

We see therefore that *Solarium nitens* exhibits no relationship whatsoever with any of the species now inhabiting the Indian Ocean and we must consider it as representing a type of *Solarium* which has died out. Its nearest relative seems the Eocene *Solarium picteti*, Desh., from the Paris Calcaire grossier; this species is distinguished by the same smooth whorls destitute of any other ornamentation, except the revolving furrows which set off revolving keels at either end of the whorls. Deshayes figure shows, however, only one keel on either side of the suture and in this regard it would more agree with *Solarium perspectivum* or *Solarium lævigatum*, but being of very small size, only 5 mm. in diameter, it is quite possible that the furrow which sets off the keel at the posterior end of the whorl has been overlooked by being too

faintly marked. If we notice how feebly it is marked in *Solarium nitens* this view is not improbable. For the present this question cannot be decided, but it is taken that *Solarium nitens* belongs to the same group as *Solarium picteti* which has probably died out.

Solarium bistriatum, Desh., which differs from *Solarium picteti*, Desh., only by the characters of the base, would have also to be considered, but inasmuch as the base is not known of *Solarium nitens*, it is impossible to say to which of the two it bears a closer relationship, though the fact that we have another species closely related to one occurring in the Eocene of Paris is beyond doubt.

The above distinguishing features will perhaps best be understood from the following diagramatic woodcut :—



Solarium maximum, Philippi, Pl. XVII, fig. 17, *a-d*.

1840. *Solarium affine*,[1] J. de Carle Sowerby, Transact. Geol. Soc. of London, 2nd Ser., Vol. V, pl. xxvi, fig. 6.
1858. „ „ d'Archiac and Haime, Descr. des Anim. Foss. du Groupe numm. de l' Inde, p. 286, pl. xxvi, figs. 13 *a*, *b*, *c*, 14 *a*, *b*, *c*.
1895. „ „ Noetling, Misc. Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 17, pl. iv, figs. 5 *a*, *b*, 6, 6*a*.

Measurements.

Height .	9·3 mm.
Width .	22·3 „
Spiral angle .	109°

The shell is circular, depressed, conical above and flat or just perceptibly convex below. It consists of at least eight angular slightly convex whorls, which very gradually increase in height.

The embryonic whorls could not be observed well, but they appear to be smooth.

The spire whorls, six in number, are separated by an ill-defined suture; they are just perceptibly convex, the ornamentation consists of five granulose revolving keels, which are separated by concave furrows. No. 1 which runs just along the margin is almost entirely hidden by the succeeding whorl, its upper edge being just perceptible behind the suture; it is separated from No. 2 by a broad and deep

[1] Though Sowerby calls this species *S. affine*, Messrs. d'Archiac and Haime called it *S. affinis* in the text, but *S. affine* in the letter press.

furrow which might be easily mistaken for the suture; No. 2 is then rather high, and separated by a broad and deep furrow from No. 3 which is broad, flat and separated by a shallow furrow from No. 4 which is somewhat thinner; No. 5 is of equal strength as No. 4, but separated from it by a deep and narrow furrow. Keels and interstices are crossed by sharp oblique, longitudinal striæ which produce the granulations on the keels.

The body whorl is in no way distinguished from the spire whorls, except that keels Nos. 3 and 4 with the intermediate furrow become almost effaced, while Nos. 1 and 2 with the accompanying furrows as well as No. 5 with its anterior furrow become more marked still.

The base is flat, perhaps slightly convex towards the aperture; close along the margin and the bordering keel No. 1 runs a narrow but deep furrow, which is separated from a finer one by a delicate, rounded keel. The central portion is smooth, but close to the wide and deep umbilicus run, separated by a granulated keel, two deep furrows. The edge of the umbilicus is set with sharp and strong radiating ridges, which extend towards the periphery, but become effaced before reaching it.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Meiocardia metavulgaris*, Singu.
Zone of *Paracyathus caeruleus*, Yenangyat.
Zone of *Cancellaria martiniana*, Minbu.
Zone of *Arca theobaldi*, Kama
Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—There cannot be the slightest doubt that the species here described is identical with *Solarium affine*, Sowerby, though his figure is rather defective. Both Messrs. d'Archiac and Haime as well as myself have, however, made a mistake in stating the number of spiral keels to be four instead of five, a mistake which is easily accounted for by the state of preservation. Unless I had been able to examine the well preserved specimen from Kama, I could not have discovered the actual number of the revolving keels, the anterior one of which is almost entirely hidden by the succeeding whorl.

There can be also no doubt that this species is identical with the *Solarium maximum*, which lives at present in the Indian Ocean, Ceylon and Java. I have been able to compare a specimen of this species, and I found that it agreed in every detail with the fossil one, except that it attained a larger size, having a width of 50 mm., while the largest fossil specimen measures just half, that is to say, 25 mm. The apical angle of the living species is 108°, that of the fossil 109°, a difference which is certainly of no importance. Much more important is, however, the absolute identity of the ornamentation; on the living species there are the same five granulated revolving keels, of which No. 1 is almost hidden by the succeeding whorl. Their strength, the width of the interstices is exactly the same in the living as in the

fossil one, and the identity goes so far that even the relative strength of the granulations of the different keels is the same. The body whorl shows the same gradual disappearance of No. 3, as observed in the fossil specimen, the only difference would be that No. 4 is perhaps a little more marked than in the fossil one. As the characters of the base are also exactly alike, I need not dwell any longer on the similarities.

That the Miocene specimens are of smaller size is quite in harmony with what we observed in other species which are either identical or so closely related to living species that they must be regarded as their direct ancestors; the fossil specimens are always smaller and more delicate than their living representatives.

Solarium maximum from Burma seems identical with *Solarium perspectivum*, K. Martin, from Java. Unfortunately Martin figures only the base of two fragmentary specimens of which, however, the characteristic ornamentation of the base of fig. 1*a* is perfectly identical with that of the specimen here described.

SOLARIUM CONIFORME, spec. nov., Pl. XVII, fig. 19, *a-b*.

A single very fragmentary specimen of this species has come under examination, but though greatly damaged, the features exhibited are sufficient to prove it a species different from all the others.

The shell must have attained a fairly large size as the specimen has a largest diameter of 29·5 mm.; it had a rather high conical shape and the apical angle was probably not more than 118°.

There are about eight rather high, angular spire whorls having a flat surface, which are separated by a sharp, though rather indistinct, suture. The ornamentation consists of about 13 to 14 rounded revolving keels separated by linear interstices. The keel, lining the ambitus, is slightly stronger than the others, while these are of somewhat unequal strength.

The body whorl seems in no way different from the spire whorls except that the ornamentation of the surface becomes rather indistinct and effaced.

The base is not well exposed, but it can be distinctly seen that the body whorl was flat and that the species was distinguished by a very wide umbilicus, the walls of which were lined with coarse wrinkles, which form also two rows along the inner edge of the whorls.

Geological occurrence.—

Zone *of Aricia humerosa*, Thayetmyo.

Remarks.—The enormously wide umbilicus, together with the ornamentation of the upper side of the whorls consisting of numerous fine, rounded revolving keels, readily distinguishes this species from all the others.

No fossil species has been described from either Java, Sumatra or Western India; I can also find no living species to which I could compare it.

2. Sub-genus: TORINIA, Gray.

TORINIA PROTODORSUOSA, spec. nov., Pl. XVII, fig. 22, *a-e*.

1895. *Solarium euomphaloides*, Noetling, Mioc. Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 18, pl. iv, figs. 7, 7*a*.

MEASUREMENTS.

Height .	4·0 mm.
Width .	9·0 „
Apical angle	160°

The shell is of small size, conical in shape, but so much depressed that it appears almost flat, and consists of about six or seven whorls which are flat above and rounded below.

The embryonic whorls were not observed.

The spire is very depressed and consists of about five whorls which very gradually increase in size and are separated by a sharp and deep suture. The ornamentation consists of very fine granulated revolving keels, which are separated by linear interstices. Generally the anterior and posterior keels are stronger than those of the central portion of the whorl.

The body whorl differs in no way from the spire whorls except that the revolving keels become more numerous; the ambitus is flattened and particularly remarkable for two linear revolving furrows which run on either side of a filiform rounded somewhat granular keel.

The base is strongly tumid and set with similar granulated keels as the upper side of the body whorl; the breadth of the keels increases towards the umbilicus, which is set with coarse, radiating wrinkles lining its wall and also extend over the two innermost keels, their number on the outer one being larger than on the inner one. Umbilicus rather wide. Aperture not observed.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.

Zone of *Arca theobaldi*, Kama.

Remarks.—This species is easily distinguished from the others by its ornamentation, consisting of very closely set granulose keels covering all the whorls, but in particular by the flattened ambitus which exhibits two fine deeply engraved furrows running on either side of a filiform granulated keel.

No similar species has been described from either Java, Sumatra or Western India.

There appears to be no doubt that the Miocene species is closely related to the living *Solarium dorsuosum* from the Andamans. The ornamentation is exactly alike, particularly the somewhat flattened ambitus, which is provided with two deeply engraved furrows running on either side of the fine keel, is well seen.

There are, however, some differences which must be recorded; in the first instance, the spire of the living species is not quite as depressed as that of the fossil one, the

apical angle is therefore more acute, measuring 140°; the keel on the ambitus almost disappears so that the two furrows seem to form a single one; apparently it attained a larger size, and the revolving keels are broader. It is for these differences that I did not identify the Miocene species with the living one, though there can be no doubt that the former is the direct descendant of the latter, having only acquired a large size and a somewhat coarser ornamentation, a feature which is in concordance with the same facts noted in other species.

In my previous memoir I identified this species with *Solarium cyclostomum*, Menke; I have now however carefully compared this species with the fossil one, and I discovered some differences which I previously overlooked. In *Solarium cyclostomum* the umbilicus is much wider than in either *Solarium dorsuosum* or the fossil *Torinia protodorsuosa*; the wall is in *S. cyclostomum* lined with fine granulations, while in *S. dorsuosum* as well as in *Torinia protodorsuosa* it is set with coarse wrinkles which extend also across the two inner keels of the base in both these species. On the upper side the whorls of *Solarium cyclostomum* are rounded and separated by a deep well marked suture, in both *Solarium dorsuosum* and *Torinia protodorsuosa* they are flat and the suture is ill-defined. For these reasons I have withdrawn the former name, and I think that the fossil species is much nearer related to *Solarium dorsuosum* than any other species. I need hardly mention that *Solarium cyclostomum* and *Solarium dorsuosum* are very closely related to each other, both being characterised by a slightly flattened ambitus of the body whorl, which bears a broad furrow with a fine central keel.

TORINIA BUDDHA, Noetling, spec., Pl. XVII, figs. 20, *a-d*, 21, *a-c*.

1895. *Trochus buddha*, Noetling, Mioc. Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 16, pl. IV, figs. 1, 1*a*, 1*b*, 2, 2*a*.

MEASUREMENTS.

Height	.	6·8 mm.
Width	.	12·8 „
Apical angle		117·6°

The shell is depressed, conical in shape, of rather small size, and consists of about seven low whorls.

The embryonic whorls have not been observed. The spire whorls four in number are low and very gradually increase in height; the sides are flat or slightly concave; the suture is very sharply marked. The earlier whorls are perfectly smooth, only a slightly indicated furrow runs along the posterior end, close to the suture. On the penultimate whorl a few indistinct smooth revolving keels begin to appear, which become stronger on the body whorl.

The body whorl differs in no way from the spiral whorls, except that its flank becomes a little more concave; the margin is rounded and the revolving keels become more numerous and distinct; they are separated by interstices which are linear near the ambitus, but become wider distant towards the suture.

The base is almost flat and covered with similar revolving keels at the upper side of the body whorl, only that the interstices increase in width from the ambitus

towards the umbilicus. The umbilicus is fairly wide, its walls are set with fine longitudinal ridges.

Aperture not observed.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.

Zone of *Paracyathus caeruleus*, Yenangyat.

Remarks.—In my first paper I classified this species under the generic name of "*Trochus*," but having it more carefully examined since I think it better to include it among the sub-genus *Torinia*. The general shape and the wide umbilicus, the wall of which is set with fine longitudinal folds, rather speak for *Solarium* than for *Trochus*. A smooth shell almost destitute of any ornamentation, except a few revolving keels on the body whorl, having a base which is covered with very regular revolving keels of equal strength, readily distinguishes this species from the other two here described.

No similar species has been described either from Java, Sumatra or Western India.

Neither could I discover any living or fossil species to which it could be compared, and we must suppose that *Torinia buddha* represents a type which is extinct among the present fauna of the Indian Ocean, but which may have a relative in the older Tertiary beds of India or Burma.

Genus: DISCOHELIX, Dunker.

There can be not the slightest doubt that the species here described really belongs to the genus *Discohelix*, Dunker. Its occurrence in the Miocene of Burma is particularly interesting, not only because it seems almost certain that it does not exist among the living fauna of the Indian Ocean, but much more so on account of the geographical distribution of this genus. The living species seems to be restricted to the Mediterranean while the fossil ones appear to have a wider range, as according to Fischer *Discohelix* occurs also in the Eocene of Alabama. If it be true that *Discohelix* is at present restricted to the Lusitanian province, the occurrence of that genus in the Miocene of Burma would be the only European feature in the Miocene fauna of Burma.

DISCOHELIX MINUTA, Noetling, Pl. XVII, fig. 23, *a-d*.

1895. *Discohelix minuta*, Noetling, Mioc. Foss. Upper Burma, Mem. Geolog. Survey of India, 1896, Vol. XXVII, p. 18, pl. IV, figs. 8, 8*a*.

MEASUREMENTS.

Height .	1·3 mm.
Width .	7·0 „
Apical angle .	180°

The shell is of very small size, perfectly flat and disciform in shape, consisting of about six flat angular whorls.

Embryonic whorls not observed.

The spire whorls are perfectly depressed, and as the body whorl is considerably higher, the upper side of the shell is slightly concave.

The whorls which are rectangular in shape, increase very slowly in width and are separated by a sharply defined suture; they are perfectly smooth, and there is no ornamentation except a sharp granulated keel which is traceable almost to the apex running along the anterior edge.

The body whorl differs in no way from the spire whorls, its upper side is gently sloping towards the apex, the ambitus is flattened and its upper as well as the lower edge set with a sharp granulated keel.

Base not observed but apparently deeply concave.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.

Remarks.—The specimen first described has remained the only one which has come under examination. As it is not very well preserved I refrain from comparing it with other species of this genus; yet it seems certain that there exists no living relative among the fauna of the Indian Ocean. In my previous memoir I mentioned that *Discohelix minuta* bears a great similarity to *Discohelix zanclea*, Phil., a view which I found no reason to change. We are therefore obliged to assume that *Discohelix minuta* is one of the very rare instances in which a species from the Miocene of Burma can be referred to a European one.

Family: *SCALARIDÆ*, Chenu.

Genus: SCALARIA, Lamarck.

On the following pages four species have been described as belonging to this genus, which can be easily distinguished as follows:—

A. Whorls connected—
- (*a*) No revolving striæ on the interstices of the longitudinal ribs.
  - (*aa*) Whorls angular, ribs numerous and closely set.
    - 1. *Scalaria spathica*, spec. nov.
  - (*bb*) Whorls rounded, ribs few, separated by broad interstices.
    - 2. *Scalaria leptopleurata*, spec. nov.
- (*b*) Revolving striæ on the interstices of the longitudinal ribs.
  - 3. *Scalaria birmanica*, Noetling.

B. Whorls disconnected—
  - 4. *Scalaria* (?) *irregularis*, Noetling.

The species here mentioned are unfortunately not particularly well preserved, and it is therefore difficult to decide to which sub-genus a certain species may belong, yet I do not think that I make a mistake if I assume that *Scalaria spathica* belongs to the sub-genus *Opalia*, *Scalaria leptopleurata* to *Clathrus*, *Scalaria birmanica* perhaps to *Cirsotrema*, while the position of *Scalaria irregularis* must remain undecided.

The relationship of these four species is varied, but of none a direct connection with a living species could be satisfactorily traced; this may be due to the state of preservation, and more complete shells allow perhaps for a better comparison. As far as I have been able to say, two species, *viz.*, *Scalaria leptopleurata* and *Scalaria birmanica*, appear to be related to species inhabiting the Indian Ocean. *Scalaria spathica* bears the closest resemblance to a species from the Paris Eocene, while no relationship could be traced of *Scalaria irregularis*.

SCALARIA SPATHICA, spec. nov., Pl. XVII, figs. 27, 27*a*.

1895. *Scalaria subtenuilamella*, Noetling, Mioc. Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 20, pl. V, figs. 3, 3*a*.

MEASUREMENTS.

Height	. 12·6 mm. (incomplete).
Width	. 6·4 mm.
Apical angle	. 22°

No other specimen but the fragment consisting of four whorls only, which I described in my previous memoir, has come under examination. The shell was apparently of small size only, and when complete, it cannot have measured much more than 20 mm. in length. The whorls are tumid but slightly flattened at the ambitus and separated by a deep suture. The surface is covered with fine but sharply raised longitudinal, somewhat obliquely inclined ribs, which are separated by slightly broader concave interstices. Ribs and interstices are perfectly smooth, and there are about 30 to 35 to one volution. The flattening of the central portion of the whorls produces a peculiar broken appearance of the ribs.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.

Remarks.—In my first paper I identified this species with *Scalaria subtenuilamella*, d'Arch., and there is no doubt that it has the greatest similarity with the species here described; it may be possible that both species are identical, yet it seems that *Scalaria subtenuilamella* had a much shorter shell with a larger apical angle, while that of *Scalaria spathica* is more elongate and the apical angle smaller. I thought it, therefore, better to distinguish this species under a new name, and leave it to future researches when the examination of the Miocene fossils from Western India will be taken up, to decide whether the two species are really identical.

Scalaria spathica resembles slightly to *Scalaria leptopleurata* and *Scalaria birmanica;* from the former it can be easily distinguished by the angular whorls, the more numerous and more closely set longitudinal ribs, from the latter by the smooth interstices.

I could not find any living relative of this species, and it may be probable that it represents an extinguished type; the character of the ornamentation is, however, so similar to *Scalaria multilamella*, Bast., from the Eocene of Paris, that I consider this species as a very near relative of *Scalaria spathica*.

SCALARIA LEPTOPLEURATA, spec. nov., Pl. XVII, figs. 24, 24a.

MEASUREMENTS.

Height .	18·0 mm.
Width .	5·2 „
Apical angle	12°

The high shell is of small size, turreted in shape and consists of more than eight tumid whorls. Unfortunately the apex is broken off, so the embryonic whorls could not be observed.

The spire whorls which are certainly not less in number than eight, are strongly inflated and increase very slowly in height. They are separated by a sharp and deep suture. The ornamentation consists in rather thin but sharp, raised longitudinal ribs, which are separated by smooth concave interstices having about double their breadth; the number of ribs to one volution cannot quite be ascertained, but the rib of each succeeding whorl follows directly in the continuation of that of the preceding one. Base not observed.

Aperture longitudinal, somewhat oblique, outer lip sharp, inner lip slightly callous.

Geological occurrence.—

Zone of *Dione dubiosa*, Yenangyat.

Remarks.—Only a single specimen of this species, which is partly imbedded in the rock, has come under examination, but it is still sufficiently well preserved to define its chief characters. It is very similar to *Scalaria birmanica*, but can be easily distinguished by a smaller number of longitudinal ribs, and particularly by the smooth interstices which are devoid of any revolving ornamentation.

If it were permitted to compare a single fossil species, which in addition is not very well preserved, with one of the living species, particularly if only a figure of that specimen is available, I should say that either *Scalaria gracilis* or *Scalaria philippinarum*, Sowb., were close relations of the species here described, both species inhabiting the Indian Ocean.

SCALARIA BIRMANICA, Noetling, Pl. XVII, figs. 25, 25a.

1895. *Scalaria birmanica*, Noetling, Mioc. Foss. Upper Burma, Mem. Geolog. Survey of India, Vol. XXVII, pl. IV, figs. 9, 9a.

1895. „ *irregularis*, Noetling, Mioc. Foss. Upper Burma, Mem. Geolog. Survey of India, Vol. XXVII, pl. V, fig. 1 (non 2 and 2a).

MEASUREMENTS.

Height .	20·6 mm.
Width .	4 „
Apical angle	15°

The elongated shell is of medium size, turreted and consists of more than ten whorls; the exact number cannot be fixed because the apex is broken off.

The spire whorls are rounded, separated by a deep suture, and increase very

gradually in height. The ornamentation consists of fine rather low longitudinal ribs of which there are about 20 to a volution which are separated by slightly broader interstices; the anterior face of each rib is set with sharply engraved, short revolving lines, separated by rather broad, flat interstices; on the earlier whorls these lines extend also partly across the interstices, but they never ascend on the posterior face of the longitudinal rib, which remains perfectly smooth.

Body whorl and aperture not observed.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.

Zone of *Cancellaria martiniana*, Minbu.

Remarks.—This species is easily distinguished from *Scalaria leptopleurata* by the larger number of longitudinal ribs, but particularly by the finely engraved lines on the anterior face of the former, of which no trace is visible in *Scalaria leptopleurata*.

K. Martin described under the name of *Scalaria samarangana*, a fragmentary specimen which appears to be related to the species under description; in fact I am not quite certain whether the two species should not be considered as identical. *Scalaria samarangana* appears, however, to have a less elongate shell with a larger apical angle, which according to Martin's figure measures about 25°. Martin mentions also the existence of "spiral ribs" in the interstices in addition to spiral lines, a feature which does not exist in the Burma species.

Scalaria birmanica, and perhaps also *Scalaria samarangana* belong to the group of *Scalaria delicatula* living nowadays in the Australian Seas.

On closer examination I have been able to convince myself that the specimen of *Scalaria irregularis* figured on Pl. IV, fig. 1, of my former memoir is really a cast of this species.

Scalaria (?) irregularis, Noetling, Pl. XVII, fig. 26.

1895. *Scalaria irregularis*, Noetling, Mioc. Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, pl. IV, figs. 2, 2a.

Only a very fragmentary specimen of this species has come under examination, consisting of about 2½ rounded whorls which are not in contact with each other; the ornamentation consists of rather irregular broad longitudinal ribs separated by broad interstices.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.

Remarks.—The fragmentary specimen under examination is unfortunately too ill-preserved to allow for any further description, except the above few words. Inasmuch as it is, however, readily distinguished by the free whorls and the somewhat irregular longitudinal ribs, it certainly represents a species different from the others. I admit, however, that it would have been better not to distinguish it by a specific name. The specimen figured under figs. 2, 2*a* of my memoir turns out on closer examination to be a cast of *Scalaria birmanica*.

I could not find any living nor fossil species to which I might compare *Scalaria irregularis*; this may, however, be only due to the imperfect state of preservation, which renders even the generic position rather doubtful.

2. Section: *TÆNIOGLOSSA*, Troschel.

I. HOLOSTOMATA.

Family: *TURRITELIDÆ*, Gray.

Genus: TURRITELLA, Lamarck.

On the following pages seven species have been described which can be easily distinguished as follows:—

A. Whorls angular, carinated.
- (a) One strong sharp keel.
  - (aa) Posterior portion of whorls with numerous fine keels.
    - 1. *Turritella angulata*, Sowerby.
  - (bb) Posterior portion of whorls with only three fine keels, smooth on body whorl.
    - 2. *Turritella simplex*, Jenkins.
- (b) Two strong sharp keels.
  - 3. *Turritella acuticarinata*, Dunker.

B. Whorls rounded.
- (a) Keels smooth.
  - 4. *Turritella lydekkeri*, spec. nov.
- (b) Keels granulose.
  - 5. *Turritella*, spec.

C. Whorls flat.
- (a) Keels arranged in two sets.
  - 6. *Turritella affiniformis*, spec. nov.
- (b) Keels evenly distributed.
  - 7. *Turritella leiopleurata*, spec. nov.

If we except No. 5, which has not been specifically determined, the six species here described represent all extinct types, as notwithstanding a certain external similarity which *Turritella simplex* and *Turritella lydekkeri* have with some species living in the Indian Ocean, no true relationship exists between them. On the other hand, it seems that *Turritella acuticarinata*, *Turritella angulata*, *Turritella leiopleurata*, *Turritella lydekkeri*, are closely related to species from the Paris Eocene, while no fossil relatives could be traced of *Turritella simplex* and *Turritella affiniformis*, which probably represent indigenous types, having their nearest relatives among the fauna of the Indian Eocene.

TURRITELLA ANGULATA, J. de Carle Sowerby, Pl. XVIII, figs. 13, 14, 15, 15*a*.

1840. *Turritella angulata*, J. de Carle Sowerby, Transact. Geolog. Survey of London, 1840, Vol. V, pl. XXVI, fig. 7.
1853. „ „ d'Archiac and Haime, Descr. des Anim. foss. du groupe Numm. de l' Inde, p. 294, pl. XXVII, figs. 6-9.

All the specimens under examination are too fragmentary to allow for any measurements, but the shell may attain a size of not less than 50 mm. It is turreted in shape and consists of numerous angular whorls separated by a deep suture. The ornamentation consists of smooth revolving keels, one of which becomes at an early age much stronger than the others, and divides the surface of the whorls into two very unequal portions; the posterior one slopes gently towards the suture and is considerably larger than the anterior portion which slopes steeply towards the suture; on the posterior portion there are from five to six fine keels of varying strength, while on the anterior portion there are about two, one of which almost equals in strength the dividing keel.

Geological occurrence.—

Unknown; probably Thayetmyo.

Remarks.—The geological horizon of this species is unfortunately not known; it is perhaps probable that this species characterises Mr. Theobald's *Turritella* bed, in which case it would occur at the top of the *Yenangyoungian*.

Turritella angulata is very closely related to *Turritella simplex* and *Turritella acuticarinata*, in fact a specific distinction is almost impossible when the specimens are not well preserved. So far I am not able to say whether there is any specific distinction between *Turritella angulata* and the other two species, but it seems that at an age when in *Turritella simplex* and *Turritella acuticarinata* No. 1 keel is not yet raised above the others, this same keel is well marked in *Turritella angulata*. It is further unquestionable that in *Turritella angulata* the proportion between the two parts of the surface of the whorls is much smaller than that of *Turritella simplex* and *Turritella acuticarinata*. With regard to the ornamentation it is unquestionable that there are a larger number of keels on the posterior portion than in either *Turritella simplex* or *Turritella acuticarinata*, and these keels do not become effaced as in those species, but keep on in the same strength up to the outer lip.

Messrs. d'Archiac and Haime have figured quite a number of varieties of *Turritella angulata* which are, however, all distinguished by the above characteristic features: a small proportion between the anterior and posterior portion of the surface, a larger number of keels, which extend up to the end of the body whorl.

Turritella angulata has apparently no living relative among the fauna of the Indian Ocean and represents therefore an extinct type, which may perhaps have a near relative in *Turritella carinifera*, Deshayes, from the Paris Eocene.

TURRITELLA SIMPLEX, Jenkins, Pl. XVIII, figs. 1, 1*a*, 2, 2*a*, 3, 3*a*, 4, 4*a*.

1864. *Turritella simplex*, Jenkins, Javan Fossils, Quart. Journ. Geolog. Soc. of London, 1864, Vol. XX, p. 59, pl. VII, fig. 6.

1879. „ „ Martin, Tertiär. auf Java, p. 67, pl. XI, figs. 10, 10*a*, 11, 11*a*.

MEASUREMENTS.

Height	.	117 mm.
Width	.	34·0 „
Apical angle	.	21°

The elongate, turreted shell attains a considerable size as one specimen, though broken at its apical end, could not have measured less than 117 mm. in length. It consists of at least 15 angular whorls, gradually increasing in height.

The embryonic whorls could not be observed in any of the specimens.

The spire whorls, of which there are certainly not less than 14, but perhaps more, change considerably in shape and ornamentation during advancing age. The first seven whorls are rounded and separated by a sharp suture; the ornamentation consists of fine but sharp revolving keels, five of which are of equal strength, but stronger than those which may be observed in the broad interstices. At a very early age keel No. 3 becomes stronger than the others, and increasing in strength the whorls become angular, because they slope in opposite direction from this keel, the posterior portion being about twice as high as the anterior portion, which slopes very steeply towards the suture. The posterior portion is still provided with three fine keels, which form a central band, while the intermediate finer lines have disappeared. On the anterior portion keel No. 2 is strong and well marked, while keel No. 1 is generally hidden by the suture. With advancing age this ornamentation becomes also effaced and the whorls appear smooth, except for numerous longitudinal striæ of growth. The body whorl differs in no way from those of the spire, its base is strongly inflated, and there is another revolving keel in front of No. 1 which on the earlier whorls coincides with the suture.

Aperture not well observed; it was apparently small, somewhat rectangular in shape; outer lip not observed, inner lip thin, inflated, perfectly covering the umbilicus.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Arca theobaldi*, Kama.
Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—This species has been well figured and described by Martin, and no doubt can exist with regard to the identity of the specimens from Burma with those described from Java.

Turritella simplex is easily distinguished from *Turritella acuticarinata* by a single sharp keel running at about ⅓ of the height of the whorls, while in the last-named species there are two such keels running closely together.

Turritella simplex bears the closest relationship to *Turritella duplicata*,

Lam., from the Indian Ocean, in fact the similarity is so great that it is difficult to discover any differences. Yet on closer examination it will be seen that both species are distinctly different though their brephic stage is almost alike. During the brephic stage the whorls are rounded in both species, and covered with fine smooth revolving chords; in *Turritella simplex* there are, however, five chords more prominent than the finer ones occurring in the interstices, while in *Turritella duplicata* there are about ten chords of equal strength separated by smooth interstices. Whether these differences are material or not I am unable to say, but the probability that both species had a common ancestor is by no means small.

The specific differences begin, however, to appear soon; keel No. 3 rises very quickly in *Turritella simplex* and the profile line of the whorls becomes very angular—a feature which is more and more accentuated with advancing age. On the posterior portion of the whorls only three fine chords remain visible, while the interstices are apparently smooth.

In *Turritella duplicata* keel No. 3 becomes also stronger than the others, but it never rises to such an extent as in *Turritella simplex;* the angle formed by the posterior and anterior portion of the whorls remains therefore much more obtuse (134°—138°) than in *Turritella simplex*, where it amounts to only 114°—118°.

In addition to this difference the surface of the whorls is covered with numerous, very fine revolving lines, of which no trace could be discoverred in *Turritella simplex*.

Though *Turritella simplex* bears therefore an external similarity to *Turritella duplicata*, there exists no further relationship between the two, except that they had perhaps a common ancestor. We must therefore suppose that *Turritella simplex* represents a type extinct among the fauna of the Indian Ocean, which most probably had its nearest relative in the Eocene of India.

TURRITELLA ACUTICARINATA, Dunker, Pl. XVIII, figs. 5, *a-b*, 6, 7, 7*a*.

1847. *Turritella acuticarinata*, Dunker, Palæontographica, Vol. I, p. 133, pl. XVIII, fig. 10.
1864. *Turritella acuticingulata*, Jenkins, Javan Fossils, Quart. Journ. Geolog. Soc. of London, 1864, Vol. XX, p. 58, pl. VII, fig. 1
1879. *Turritella acuticarinata*, Martin, Tertiär. auf Java, p .69, pl. XII, figs. 3 and 4.

MEASUREMENTS.

Height . .	60 mm.
Width . .	23 „
Apical angle .	25°—27°

The shell is elongately turreted, and though of considerable size it appears that it does not attain the largeness of *Turritella simplex*. It further seems certain that the apical angle changes with advancing age; in younger specimens it was apparently smaller than in full grown ones, where it becomes slightly larger from the moment the ornamentation begins to change. This feature is well illustrated by fig. 5, so that there can be no doubt about this change taking place.

The embryonic whorls have not been observed in any of the specimens under examination.

The spire consists of not less than 10 whorls, which very gradually increase in height and in the earlier whorls are separated by a sharp and well marked suture which becomes, however, less distinct later on. The first five or six whorls are slightly rounded and are set with five revolving keels of almost equal strength, of which Nos. 3 and 4 seem slightly stronger than the others; these keels are separated by broad interstices which are filled out by an irregular number of much finer filiform revolving lines. Very soon No. 3 keel commences to get stronger and more prominent than the others, and the sides of the whorls begin to slope in opposite direction from this keel; afterwards keel No. 4 commences to become stronger and soon attains the same strength as No. 3, both being separated by a broad concave furrow; the ornamentation on the posterior portion of the whorls begins to disappear, at the same time the sides become concave and only keel No. 2 on the anterior portion remains visible.

The body whorl affords therefore a totally different aspect from the earlier spire whorls; two strong and sharply raised revolving keels separated by a broad concave furrow run at about the middle of its height, the upper portion being slightly concave and smooth, the lower portion or base strongly inflated and set with two fine revolving keels, one of which representing No. 2 is almost obliterated, while No. 1 in front of the latter which on the earlier whorls just runs underneath the suture is slightly stronger. The body whorl is just perceptibly deflected, as is distinctly proved by the appearance of No. 1 keel which, as already stated, is on the earlier whorls hidden beneath the suture and now becomes visible on the penultimate whorl above it. The deflection is further proved by the two strong keels, which, instead of running parallel to those of the penultimate whorl, form a distinct angle with them.

Aperture not well observed; apparently somewhat rectangular; inner lip inflected and covering the umbilicus.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—There can be not the slightest doubt that this species is identical with Dunker's *Turritella acuticarinata*, the ornamentation of this species is too characteristic not to be recognized. Martin has demonstrated that *Turritella acuticingulata*, Jenkins, must be considered as identical with Dunker's species, and he also dwelt on the fact that certain varieties resemble young specimens of *Turritella simplex*. *Turritella acuticarinata* is in fact very closely related to *Turritella simplex*, and at the first glance both might be considered as one and the same species; there is no doubt that during the brephic stage both species are exactly alike, and that a specific distinction at that age is impossible; it is only during the neanic stage that the differences which separate both species commence. Full grown specimens of *Turritella acuticarinata* are easily distinguishable by two sharp keels separated by a deep concave furrow, while in *Turritella simplex* the same part of the whorl is occupied by a single sharp keel.

There is no living species among the fauna of the Indian Ocean related to

Turritella acuticarinata which therefore represents an extinct type; on the other hand, there is not the slightest doubt that it is closely related to *Turritella fasciata*, Lmk., from the Paris Eocene.

TURRITELLA LYDEKKERI, spec. nov., Pl. XVIII, figs. 11, 12, 12a.

MEASUREMENTS.

Height	. 52 mm. (incomplete).
Width	. 14·5 „
Apical angle	. 15°

The shell is of elongate turreted shape, and its total length cannot have been less than 70 mm.; unfortunately both specimens are incomplete, but the complete shell must have consisted of not less than 15 slightly rounded whorls.

The embryonic whorls have not been observed. The spire whorls are rounded, slowly increasing in height and separated by a deep and sharp suture. The ornamentation consists of about ten fine, smooth revolving keels, separated by broader interstices, in which now and then a secondary, very fine keel can be seen. Nos. 1 and 2 keels are slightly stronger than the others, and No. 1, which runs close to the suture, is separated from it by a rather broad, slightly concave band, and by another band of the same breadth from No. 2 keel, both are covered with a number of filiform secondary keels. The body whorl seems to differ in no way from the spire whorls, and its base is slightly rounded and smooth.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—The general shape and the ornamentation distinguishes this species easily from all the others; it has only some similarity with *Turritella leiopleurata*, from which it is, however, easily distinguished by the rounded whorls, and the numerous keels.

Turritella lydekkeri resembles so closely two species from the Indian Ocean, *viz.*, *Turritella bacillum*, Lmk., and *Turritella infraconstricta*, Lmk., particularly to the first named, that at the first glance it might be mistaken for either of them. A closer examination will, however, prove that there is no true relationship between them.

Turritella bacillum and *Turritella lydekkeri* have perfectly different earlier spire whorls; in the former species they are angular and carinated, and become afterwards rounded and eventually flattened; in *Turritella lydekkeri* they are rounded throughout, and none of the keels on the earlier spire whorls is stronger than the others, but they are all of sub-equal strength.

Turritella infraconstricta has very similar, rounded whorls as *Turritella lydekkeri*, but their ornamentation is different; in the fossil species there are rather strong revolving keels separated by broad interstices, in which a few finer chords are visible; in *Turritella infraconstricta* the whole surface is covered with very fine closely set, revolving chords. Though it is therefore undoubtable that *Turritella lydekkeri* represents a type which is extinct among the present

fauna of the Indian Ocean it is very probable that it has its nearest relative in *Turritella sulcifera*, Des., from the Paris Eocene.

TURRITELLA, spec., Pl. XVIII, figs. 8, 8*a*.

There are two fragmentary, much rolled specimens of a *Turritella* which by the few characters that remain, prove that they represent a species different from those hitherto described. As however the state of preservation is too fragmentary, I have refrained from distinguishing them under a special name.

The shell apparently attained only a small size and consisted of about nine slightly tumid whorls which were separated by a sharp suture. The ornamentation consists of revolving granular keels; the granulations seem to have been connected by thin longitudinal lines producing a kind of lattice work.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.

TURRITELLA AFFINIFORMIS, spec. nov., Pl. XVIII, figs. 9, 9*a*.

1895. *Turritella affinis*, Noetling, Mioc. Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, pl. V, figs. 4, 4*a*.

MEASUREMENTS.

Height .	. > 40 mm.
Width .	. 16·5 „
Apical angle	. 25°.

The shell seems to have attained a considerable size, though there is not a single specimen completely preserved. It is very regularly turreted in shape and composed of flat whorls, gradually increasing in height.

The embryonic whorls have not been observed. The spire is composed of at least 10 flat whorls which are separated by a sharp, though ill-marked suture. The ornamentation consists of smooth, rounded revolving keels of which ten are arranged in three groups; the most anterior group contains the strongest keels and is composed of three, two broad outer and a finer inner one which is separated by a broader furrow from the anterior, than from the posterior one; then follows a group of five keels separated by sharply engraved interstices increasing in strength in posterior direction, the last one being the broadest, and then two very faint, hardly distinct keels separated by a broad flat band from the suture. The whole surface is covered by very fine, hardly discernible oblique striæ.

Body whorl not observed, but probably exactly like the spire whorls.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.

Zone of *Paracyathus caeruleus*, Yenangyat.

Remarks.—This species is easily distinguished from the others by its very flat whorls, and in this character it only resembles *Turritella leiopleurata*, but from this species it is easily distinguished by a larger apical angle, and particularly by

the arrangement of the revolving keels in three distinct groups of different character; in *Turritella leiopleurata* there are a smaller number of primary keels which are not arranged in groups, but evenly distributed over the surface of the whorls.

In my first memoir I identified this species with *Turritella affinis*, d'Archiac and Haime, but I already remarked on some differences which appear to characterise the specimens from Burma. On closer examination I think it, however, better to consider the Burma specimens as a different species. They are certainly different with regard to the shape of the shell which must have been very elongate or, in other words, had a very small apical angle in *Turritella affinis*, while it was shorter and had a larger apical angle in *Turritella affiniformis*. If Messrs. d'Archiac and Haime's figures are correct, then an easy distinction can be found in the character of the ornamentation, which though very similar would differ in the following features, *viz.* :—

(*a*) There are altogether more keels in *Turritella affiniformis* than in *Turritella affinis*.

(*b*) The most anterior group is composed of three keels in *Turritella affiniformis*, of two keels in *Turritella affinis*.

No living relative of this species could be found among the fauna of the Indian Ocean, and it represents an extinct type, which probably had its nearest relatives in the Indian Eocene.

TURRITELLA LEIOPLEURATA, spec. nov., Pl. XVIII, figs. 10, 10*a*.

MEASUREMENTS.

Height	.	49 mm.
Width	.	10 „
Apical angle	.	12°

The shell is very elongate, turreted in shape having a small apical angle only. It is composed of not less than 20 flat whorls growing slowly in height.

The embryonic whorls are not observed, but it appears that they were filled out by secreted matrix.

The spire whorls, of which there are not less than twenty, have flat almost plane sides and are separated by an indistinct suture. The ornamentation consists of five smooth revolving keels which are separated by broad interstices; No. 1 keel is thicker than the others, and the interstices are filled out by a number of very fine filiform lines.

Body whorl not known, but apparently much the same as the spire whorls; base probably flat.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—At the first glance this species might be mistaken for *Turritella affiniformis*, but on closer examination it will be seen that it can be distinguished by a much more elongate shell, that is to say, a shell having a smaller apical angle, but particularly by the ornamentation of the whorls which consists of five rounded keels

regularly distributed all over the surface and separated by broad interstices and not arranged in groups as in *Turritella affiniformis*.

No living relative of this species could be found which unquestionably represents a type extinct among the fauna of the Indian Ocean, though it appears as if *Turritella dixoni*, Des., from the Paris Eocene is a near relative.

2. Family : *VERMETIDÆ*, Adamson.

Genus : VERMETUS, Adamson.

VERMETUS JAVANUS, K. Martin, Pl. XVIII, figs. 16, *a-b*, 17, *a-b*, 18, 18*a*, 19, 19*a*.

1879-80. *Vermetus javanus*, K. Martin, Tertiär. auf Java, p. 77, pl. XIV, fig. 13.

The shell is extremely irregular in shape and consists of a tube measuring 4 to 6 mm. in diameter, which grows in the most irregular way. It appears, however, that in the earlier part of its life the animal formed a sort of an irregular spiral and stretched afterwards in one direction only. The surface is covered with rather regular granulose keels, or rows of isolated granulations extended in the direction of the axis of the shell.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.
Zone of *Aricia humerosa*, Thayetmyo.
Zone of *Cytherea erycina*, Prome.

Remarks.—The peculiar ornamentation consisting in granulated keels or rows of sharp round granulations stretched in the longitudinal axis of the shell are, according to Martin, the chief character of *Vermetus javanus*. As the specimens under examination exhibit the same character, it cannot be doubtful that they are identical with Martin's species, particularly as they exhibit the same feature as *Vermetus javanus*, namely, an irregular spiral at the beginning and a stretched though variously curved tube.

It seems to me that *Vermetus javanus* exhibits the greatest similarity to *Siliquaria multistriata*, Des., and *Siliquaria striata*, Des.,[1] from the Paris Eocene, a feature which was probably overlooked by K. Martin.

Genus : SILIQUARIA, Brugiére.

Two species which probably belong to this genus have come under examination, but both are so poorly preserved that, though it is quite certain that they represent different species, it is impossible to form any view as to their relationship.

[1] Both species seem to me identical.

Siliquaria, spec. 1, Pl. XVIII, figs. 20, 20a.

1895. *Siliquaria*, sp., Noetling, Miocene Foss. Upper Burma. Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 22.

The specimen mentioned in my previous memoir has remained single, and I can add nothing to the remarks then made. It consists of about five free whorls rolled up in an irregular spiral, the whorls gradually increasing in height and in thickness. The surface was covered with numerous sharp, somewhat irregular longitudinal ribs, appearing more like closely set irregular lamellæ.

Geological occurrence.—

Zone of ***Paracyathus caeruleus***, Yenangyat.

Remarks.—I previously remarked that this species exhibits some similarity with *Siliquaria granti*, Sow., though this species seems to have attained a larger size.

Siliquaria, spec. 2.

Different from the previous species though too ill-preserved to be described under a specific name, is another species which seems to be characterised by a tube of elliptical section bearing a sharp keel or fissure (?) at one side. The earlier part of the tube seems to form rather a regular spiral, but afterwards it stretches in a straight direction.

Geological occurrence.—

Zone of ***Mytilus nicobaricus***, Singu.

Remarks.—The different section, but particularly the sharp keel which probably corresponds to a fissure on one side, proves that this must be a different species from *Vermetus javanus*, in which I never observed a similar fissure, and the latter character distinguishes it also from *Siliquaria*, spec. 1.

Family: *XENOPHORIDÆ*, Deshayes.

Genus: XENOPHORA, Fischer de Waldheim.

Xenophora birmanica, spec. nov., Pl. XVIII, figs. 21, 21a.

Measurements.

Height .	18 mm. (incomplete).
Width .	34 „
Apical angle	63° (not quite certain).

Only a single species, which is damaged at the apex, has come under examination.

The shell is of medium size, highly conical and consists of irregular inflated whorls which rather quickly increase in height. Embryonic whorl not observed.

There are about three spire whorls preserved which are separated by a deep suture. The whorls are angular, the surface inflated, but very uneven on account of the numerous foreign bodies that have been agglutinated to the shell. It appears that there were two rows of agglutinated marine débris, one in the centre of the upper

surface of the whorls and one along their ambitus. When not covered by foreign matter, the surface of the whorls exhibited a laminous appearance.

Body whorl exactly like the spire whorls.

Base and aperture not observed.

Geological occurrence.—

Zone of *Aricia humerosa*, Thayetmyo.

Remarks.—It is unquestionable that this species belongs to the genus *Xenophora*, and not perhaps to *Onustus*, as there are no spines along the ambitus.

Messrs. d' Archiac and Haime described under the name of *Trochus cumulans*, Al. Brog. var., a species which unquestionably belongs to the genus *Xenophora*, and to judge from the general shape it may perhaps be identical with the Burma species, though Messrs. d'Archiac and Haime seemed to have doubts whether the species described by them was really identical with Brogniart's *Trochus cumulans*. As, however, the specimen from Western India appears to be a cast, it would be very difficult to ascertain its identity with *Xenophora birmanica*.

Under the name of *Xenophora agglutinans*, K. Martin,[1] described a species from Java which, to judge from this figure, is very likely idèntical with *Xenophora birmanica*, but as Martin gives no further description but only states that the specimens examined by him are identical with *Xenophora agglutinans*, Lamk., I am unable to say whether my view is correct or not.

Bœttger [2] describes under the name of *Xenophora subconica* a cast from the Miocene of Sumatra which might perhaps be identical with this species, but being a cast only, it will be difficult to say what were the characters of the surface.

The distinction of the different species composing the genus *Xenophora* seems to be based on rather vague lines, as nobody seems to have ascertained which features would form distinctive specific characters. This drawback is particularly felt in fossil specimens, which generally exhibit very indifferent features. It certainly appears that, as has already been noticed by Reeve,[3] the mode of agglutination of marine débris varies in the different species, and this feature might perhaps be useful in the determination of the fossil species.

Family: *CAPULIDÆ*, Cuvier.

Genus: CALYPTRÆA, Lamarck.

CALYPTRÆA RUGOSA, Noetling, Pl. XVIII, figs. 22, *a-b*, 23, *a-b*.

1895. *Calyptræa rugosa*, Noetling, Marine Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 22, pl. V, figs. 6, 6*b*, 7.

MEASUREMENTS.

Height . .	8·5 mm.
Width . .	23·5 ,,
Apical angle .	118°

The thin shell is of moderate size, somewhat irregular and depressed, conical in shape. The shape changes considerably during the different stages, and with it

[1] Tertiär. Java, p. 71, pl. XII, fig. 6.

[2] Tertiär Sumatra, pl. VIII, fig. 10.

[3] Monograph of the genus *Phorus*, 1843.

the size of the apical angle, the young specimens are regularly conical in shape and the apical angle measures 90°; fully grown specimens become more depressed, and the apical angle larger.

The number of whorls cannot be fixed accurately because the suture is very indistinct, but there may have been five altogether.

The embryonic whorls are very sharply developed; they form a small, *Natica*-like protoconch composed of two smooth whorls, and they are well separated from the other whorls which have become almost entirely amalgamated.

The spire whorls very suddenly increase in height and the body whorl which occupies almost half of the total height, is broadly expanded, but slightly concave on its upper part, having its edge sometimes sharply turned downwards. The surface is covered with spiral lines, which are rather regular and fine on the spire whorls, but become coarse and irregular wrinkles on the body whorl. More conspicuous is the longitudinal ornamentation, consisting of fine, but irregular, short wrinkles which are very closely set covering the whole surface; on the spire whorls these wrinkles run perpendicular to the spiral striæ, but this regularity soon disappears, and on the body whorl they appear to radiate from the apex. Lower surface not observed.

Geological occurrence.—

Zone of ***Mytilus nicobaricus***, Singu.
Zone of ***Paracyathus caeruleus***, Yenangyat.
Zone of ***Cancellaria martiniana***, Minbu.
Zone of ***Arca theobaldi***, Kama.
Zone of ***Pholas orientalis***, Thayetmyo.
Zone of ***Aricia humerosa***, Thayetmyo.

Remarks.—The specimen described in my previous memoir appears now to be a juvenile one, because I have since examined specimens from Kama, which show a perfectly different shape of the shell when in the ephebic stage.

Reeve distinguishes a number of living species the distinctive features of which are sometimes so minute, that it will be almost impossible to use them for palæontological purposes. *Calyptræa rugosa* belongs to that group of species of which we may consider *Calyptræa cicatricosa*, Reeve, to be the type. The group includes rather flat shells, having a peculiarly crumbled surface which is covered all over by minute fine radiating striæ.

Calyptræa rugosa seems closely related to *Calyptræa dormitoria*, Reeve, from the Philippine Islands, though without comparison it is impossible to say whether my view is correct or not, Reeve's figure and description being equally defective.

Family: *NATICIDÆ*, Forbes.

Genus: NATICA, Adamson.

This genus is only represented by four species which can be easily distinguished in the following way:—

A, Spire depressed.

1. *Natica callosa*, Sowerby.

B. Spire elevated.
 (a) Whorls smooth.
  (aa) Umbilicus narrow.
   2. *Natica obscura*, Sowerby.
  (bb) Umbilicus wide.
   3. *Natica gracilior*, spec. nov.
 (b) Whorls costated.
   4. *Natica*, spec.

Considering the indifferent features the species of *Natica* exhibit, it seems almost futile to attempt any comparison with living species, and even a comparison with fossil ones must remain very doubtful if figure and description only can be studied. Nevertheless it seems certain that two of the species here described, *viz.*, *Natica callosa*, Sow., and *Natica obscura*, Sow., are identical with species occurring in Western India, and as *Natica callosior* is probably identical with *Natica callosa*, the first named species would range from Western India to Java. I have not been able to discover any living relative, or to express myself more correctly. I found only too many species which resemble so closely to *Natica callosa* that I found it impossible to discern which may be the nearest relative.

Natica obscura is, on the other hand, closely related to *Natica lineata* from the Indian Ocean, while no relationship could be traced for *Natica gracilior* or *Natica*, spec.

NATICA CALLOSA, J. de Carle Sowerby, Pl. XVIII, figs. 24, *a-b*, 25*a*; Pl. XIX, fig. 1, *a-d*.

1840. *Natica callosa*, J. de Carle Sowerby, Transact. Geolog. Soc. of London, 2nd ser., Vol. V, pl. XXVI, fig. 3.

1895. „ „ Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 28, pl. V, figs. 8, 8*a*.

MEASUREMENTS.

Height .	28 mm.
Width .	25 „
Apical angle .	100°

The shell is of moderate size, almost globular in shape, somewhat oblique and composed of about five whorls, forming a very low spire and large body whorl. Embryonic whorls not observed.

The spire whorls, which are about four in number, are separated by a sharp well-defined suture, their surface is flat and they increase at first slowly, but later on rapidly in height, forming a spire which occupies not more than one-eighth of the total height, while the ventricose body whorl is of great size, almost occupying the whole height.

There is no other ornamentation, except numerous very fine and densely crowded longitudinal striæ.

The aperture is large, elongated; the outer lip sharp, the inner lip callous, covering partly the deep umbilicus.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.
Zone of *Paracyathus caeruleus*, Yenangyat.
Zone of *Arca theobaldi*, Kama.
Zone of *Parallelipipedum prototortuosum*, Kama.
Zone of *Aricia humerosa*, Thayetmyo.
Zone of *Cytherea erycina*, Prome.

Remarks.—This species is easily distinguished by its extremely low spire and its comparatively enormous, ventricose body whorl which seems to compose the whole shell.

There seems to me no doubt that this species is identical with Sowerby's *Natica callosa* which is distinguished by the same characters.

Martin describes a *Natica callosior* from Java which seems to be related to this species if it is not identical. *Natica callosior* exhibits the same low spire and the same large and ventricose body whorl, the only difference I can discover is formed by an apparently differently shaped inner lip; in *Natica callosior* it is very broad, in *Natica callosa* rather narrow, but whether this is really a specific difference or not, I am unable to say without comparing the two species.

NATICA OBSCURA, J. de Carle Sowerby, Pl. XIX, figs. 2, *a-b*, 3, *a-d*.

1840. *Natica obscura*, J. de Carle Sowerby, Transact. Geolog. Soc., London, 2nd series, Vol. V, pl. XXVI, fig. 2.
1895. " Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 22, pl. V, figs. 6, 7, 7*a*, 7*b*.

MEASUREMENTS.

Height	. 15 mm.
Width	. 13·9 "
Apical angle	. 108°.

The shell is subglobular in shape of moderate size, and composed of six whorls forming a slightly raised spire and a large body whorl.

Embryonic whorls not observed.

The spire which, though low, is well raised above the body whorl, is composed of four slightly inflated whorls which are separated by a deep suture and rapidly increase in height; the body whorl is large, ventricose, slightly concave at its posterior part along the suture. The whorls are smooth except for numerous, fine, longitudinal striæ of growth. The aperture is large, elongated but broad; the outer lip sharp, the inner lip callous, partly covering the deep umbilicus.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Cancellaria martiniana*, Minbu.
Zone of *Paracyathus caeruleus*, Yenangyat.
Zone of *Arca theobaldi*, Kama.
Zone of *Parallelipipedum prototortuosum*, Kama.

Zone of *Pholas orientalis*, Thayetmyo.
Zone of *Aricia humerosa*, Thayetmyo.
Zone of *Cytherea erycina*, Prome.

Remarks.—Though of great similarity to *Natica callosa*, this species is readily distinguished by the more elevated spire, consisting of rounded whorls; the ratio between spire and body whorl appears therefore less disproportionate than in *Natica callosa*. The slight flattening of the body whorl along the suture is another distinguishing feature of *Natica obscura*.

There can be no doubt that the specimens from Burma are identical with Sowerby's *Natica obscura*; the slightly raised spire, the flattening of the body whorl along the suture are features which are well expressed in Sowerby's figure. *Natica rostalina*, Jenkins, is apparently a close relative to *Natica obscura*, Sow., if it is not identical altogether, and it seems strange that neither Jenkins nor Martin should have noticed this similarity.

Any comparison with living species, the specific difference of which depends so much on the colour, seems rather risky, but I think that *Natica lineata*, living in the Indian Ocean, is the closest relative: this species exhibits the same shape, the elevated spire, and whorls slightly flattened near the suture; there is further the same large umbilicus with the strong umbilical callosity; taking everything into consideration it is quite probable that *Natica callosa* is the direct ancestor of *Natica lineata*, but it will perhaps be better to refrain from a definite opinion considering the rather indifferent features the fossil species exhibits.

NATICA GRACILIOR, spec. nov., Pl. XIX, fig. 4, *a-e*.

MEASUREMENTS.

Height .	. 9 mm.
Width .	. 6 „
Apical angle	. Not measured.

The delicate shell is of very small size, rather globose and composed of a slightly elevated spire and a large body whorl

Embryonic whorls not observed.

The spire is composed of about three, almost flat whorls which increase very slowly in height, and are separated by such a deep suture that it appears as if the whorls were hardly touching each other. There is no ornamentation except numerous fine striæ of growth.

The body whorl is rather high and occupies more than half of the total height; its surface is slightly flattened and the ornamentation consists of fine striæ of growth only.

The aperture is rather large, elongated but not very broad; outer and inner lip sharp; umbilicus large, wide, no umbilical callosity.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—The elevated spire, together with the wide umbilicus without any callosity and whorls which hardly seem to touch each other, readily distinguish this species from all the others here described.

NATICA, spec., Pl. XIX, figs. 5, 5*a*.

Only a single ill-preserved specimen of a *Natica* has come under examination, which proves by the character of its surface that it cannot belong to any of the other species here described.

The shell was apparently of small size only, about the size of *Natica obscura*, and globular in shape; the spire is very low, depressed, consisting of a few whorls only; the last whorl large and globose; the surface is not smooth but covered with plicose striæ of growth, sometimes assuming the shape of irregular longitudinal ribs.

Aperture and umbilicus not observed.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Remarks.—I have refrained from distinguishing this species by a special name because of its badly preserved state which does not allow to fix all the characters with accuracy. There is, however, no doubt that the species under examination differs from all the others by its coarsely wrinkled surface, which is not perhaps the result of weathering but is unquestionably original.

Genus: SIGARETUS, Lamarck.

SIGARETUS NERITOIDEUS, Linné, Pl. XIX, figs. 6, *a-b*, 7, 7*a*.

1895. *Sigaretus bicostatus*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 23, pl. V, figs. 9, 9*a*.

MEASUREMENTS.

Height .	. 16 mm.
Width .	. 19 „
Apical angle	. 110°

The rather thick shell which attains a fairly large size is obliquely oval in shape, rather compressed; the spire is very small, the body whorl very large.

Embryonic whorls not observed.

There are four, slightly inflated spire whorls, very slowly increasing in height, separated by a sharp suture, which form a very low hardly projecting spire.

The whorls increase very rapidly in height, merging into the very large and strongly inflated body whorl. The ornamentation is the same on spire and body whorls, and consists of numerous regular, very fine, rounded revolving keels which are separated by interstices of about the same breadth. On the body whorl finer keels appear in the interstices and the ornamentation loses somewhat its previous regularity. A few coarse striæ of growth visible.

The aperture is large and wide, pyriform in shape, pointed posteriorly and broadly rounded anteriorly; the outer lip is thick, the inner lip callous, covering the slit-like umbilicus.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Paracyathus caeruleus*, Yenangyat.
Zone of *Parallelipipedum prototortuosum*, Kama.
Zone of *Cytherea erycina*, Prome.

Remarks.—When I first described this species I had unfortunately nothing but an apparently juvenile specimen for examination. Having now examined full grown specimens I have convinced myself that they must be identified with the living *Sigaretus neritoideus*, Lin., from the Indian Ocean. The shape, in particular that of the last whorl and the ornamentation of the surface are exactly the same in both the living and the fossil species, only that the former seems to have attained a large size.

The specimens from Kama are not well preserved, as they are all more or less weathered and very friable; but notwithstanding this drawback, the specific characters could be ascertained to such a degree that there can be no doubt as to the determination.

Family: *LITTORINIDÆ*, Gray.

Genus: FOSSARUS, Philippi.

FOSSARUS KRAUSEI, spec. nov., Pl. XIX, fig. 8, *a-e*.

MEASUREMENTS.

Height	. 8·3 mm.
Width	. 9·0 „

The small shell is strongly tumid, having a very low and depressed spire and very large body whorl.

The contabulate spire is apparently composed of three very low whorls which very slowly increase in height; the strongly inflated body whorl expands very suddenly and almost envelopes the whole of the spire; its posterior part is flattened, even somewhat concave and separated by a sharp keel from the anterior part; the latter and the base completely pass into each other and are set with five strong, smooth, spiral keels; these keels are separated from the marginal keel by a very broad concave interstice, in which a fine spiral keel is perceptible. Amongst themselves they are separated by interstices gradually decreasing in width towards the umbilicus.

The umbilicus is small, slit-like.

The aperture is oval and rather large and funnel shaped; the outer lip sharp, expanded and slightly sulcate; the inner lip is sharp and expanded.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Remarks.—Only a single species has come under examination, but being exceedingly well preserved its characters could be definitely fixed.

The generic position seemed somewhat doubtful at first, inasmuch as the shell seemed to exhibit features, according to which it belonged to the genus *Delphinula*, but the ornamentation, the character of the aperture in connection with the contabulate spire proved unquestionably that it belonged to the genus *Fossarus*, Phil. The extremely low spire, and in comparison the enormous body whorl distinguish it from all other species.

No similar species are so far known from either Java, Sumatra or Western India, nor could I discover any living relative among the fauna of the Indian Ocean, and *Fossarus kraussi* unquestionably represents an extinct type. On the other hand this species has a very close relative in *Nerita pentastoma*, Desh., from the Eocene of Paris; the general shape of the shell, which is distinguished by the low spire and the enormous last whorl, is the same, as well as the ornamentation of the latter consisting of sharp revolving ribs; the differences are, however, at once obvious; there are more of them in the Eocene species, particularly on the upper part of the last whorl, between the spire and the ambitus, where there are four ribs in the Eocene species, while it is free of them in the species from Burma. There is further a longitudinal striation, particularly in the interstices of which no trace can be found in the Miocene species. The most important difference seems, however, the denticulated inner lip, while in the Miocene species it is perfectly smooth.

Whether generic position of *Nerita pentastoma* which Cossman considers as identical with *Nerita tricarinata*, Lmk.,[1] is correct seems open to doubt.

I—I. SIPHONOSTOMATA.

Family : *STROMBIDÆ* Adams.

Genus : RIMELLA, Agassiz.

RIMELLA CRISPATA, Sowerby, spec., Pl. XIX, figs. 9, *a-d*, 10, 10*a*.

1851. *Rostellaria crispata*, Reeve, Monograph of the Genus *Rostellaria*, pl. III, fig. 8.

MEASUREMENTS.

Height .	. 11·5 mm.
Width .	. 4·4 „
Apical angle	. 33°

The fusiform shell is of very small size and consists of about six whorls forming an elongated spire.

Embryonic whorls not observed.

The spire whorls, probably not less than five in number, are inflated and separated by a deep suture; as they increase only slowly in height, the spire occupies about half of the total height. The ornamentation consists of 18 to 20

[1] Catal. Rais. des Foss. Eoc. de Paris, Vol. III, p. 87.

sharply raised longitudinal ribs separated by broader concave interstices, which are covered with numerous fine, but sharply engraved, equidistant revolving lines which do not extend to the top of the ribs. The body whorl is rather large, inflated and produced into a short collumella; the ornamentation is the same as that of the spire whorls; six or seven sharply engraved spiral lines are visible on the columella.

The aperture is large, elongate, somewhat oblique and produced into a long posterior canal extending upwards of the penultimate whorl, where it is strongly bent backwards; the anterior canal is very short; the outer lip thick, slightly bent backwards and internally cancellated. The inner lip is sharp, raised, covering with its anterior end the slit-like umbilicus.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Remarks.—Messrs. d'Archiac and Haime have described from Western India quite a number of species belonging to this genus, many of which are, however, founded on rather fragmentary specimens. An identification from the figure and description only is under these circumstances almost out of question. The only species with which *Rimella crispata* could be compared is *Rostellaria rimosa*, Sow. ? var. That the authors were extremely doubtful as to their determination is not only indicated by a query, but in addition to that, by the word "var.," in other words, they consider the specimen as a doubtful variety of *Rostellaria rimosa*, Sow. That the specific determination of a fragment being composed of barely two volutions must remain doubtful, requires no explanation, particularly when the said fragment is identified with a type represented by an equally badly preserved specimen.

Under these circumstances I refrain from any comparison with either species, though it is perhaps probable that *Rimella crispata* is identical with *Rostellaria rimosa*, Sow., this species having apparently the same fine and short revolving lines in the interstices between the longitudinal ribs; but the length of the posterior canal which is of chief importance cannot be made out from Sowerby's figure, and under these circumstances I preferred to give a new name to the specimens from Burma which in addition seem to be distinguished by a smaller size.

Among the living species only two species with which *Rostellaria crispata* could be compared can come in question. These are *Rostellaria cancellata*, Lamarck, and *Rostellaria crispata*, Sowerby, from the Philippine Islands, both of which are closely related to each other, the former differing by a longer posterior canal almost extending up to the apex, from the latter which is distinguished by a short one curved backwards on the penultimate whorl. In addition to this character, which according to living species I examined, seems somewhat variable, that is to say, in *Rimella cancellata* the posterior canal is a little shorter, while in *Rimella crispata* it is a little longer, there are some other and perhaps more distinctive characters which cannot be seen in Reeve's figures of both species. In *Rimella crispata* the longitudinal ribs are rather thin and separated by broad intervals, a feature which is visible even on the earlier spire whorls; in *Rimella cancellata*

just the opposite takes place; the ribs are thick and the intervals narrow; in the former species there are therefore only 18 ribs to one volution, while the latter shows not less than 26. Another distinctive feature is the outer lip which is perfectly smooth in *Rimella crispata*, while its outer side is covered with very irregular lamellar plications, which unquestionably correspond to the revolving chords.[1]

It is therefore obvious that under these circumstances *Rostellaria crispata* is much nearer related to the species under description than *Rostellaria cancellata*, and I think that there can be no doubt as to the identity of the fossil and living species.

Family: *CYPRAEIDÆ*, Gray.

Genus: CYPRÆA, Linné.

CYPRÆA GRANTI, d'Archiac and Haime, Pl. XIX, fig. 12, *a-d*.

1853. *Cypræa granti*, d'Archiac and Haime, Descr. des Anim. foss. du Groupe Num. de l'Inde, p. 332, pl. XXXII, figs. 14, 14*a*.

1895. „ „ Noetling, Mioc. Foss., Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, pl. V, figs. 12, 12*a*, 12*b*.

MEASUREMENTS.

Length	20·3 mm.	16·2 mm.
Width	13·7 „	11·7 „
Height of apex of last whorl above base	10·0 „	8·5 „

The shell is of small size only, ventricose and pyriform in shape; broadly rounded at the posterior, attenuated at the anterior extremity. The upper surface is strongly and regularly inflated, perfectly smooth; the lower surface is slightly tumid; the aperture is not quite central, slightly curved and very narrow but perceptibly expanded at either extremity; the outer lip is broad, set off against the upper surface by a sharp keel, inflated and externally covered with about 18—19 strong transverse plications; the inner lip is of about double the breadth of the outer one, otherwise its characters are the same as those of the inner lip. Both canals very short.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Meiocardia metavulgaris*, Singu.
Zone of *Cancellaria martiniana*, Minbu.
Zone of *Paracyathus caeruleus*, Yenangyat.

[1] In Reeve's monograph the two species show just the opposite character of the lip as here described; in *Rimella crispata* the lip is plicated, while in *Rimella cancellata* it is smooth. All the specimens in the Indian Museum show the character of the lip as above described, but the probability that this character is subject to variation cannot be denied. If, on the other hand, this character is really a distinctive feature of both species, an error in the determination of the living specimen I examined, may have occurred. However that may be, the fossil specimen is identical with the living one which is characterized by thin longitudinal ribs, broad intervals and a smooth outer lip.

Remarks.—The specific distinction of the *Cypræa* is extremely difficult if the rather monotonous features of the shell have to be depended on, as is most decidedly the case with fossil specimens. The specific differences of the living species are almost exclusively based on the colour, a character which is of course absent in fossil species. We are therefore obliged to rely on the differences in the shape of the shell, which on account of its rather monotonous character are extremely difficult to define. These difficulties are greatly enhanced when we have to judge from figures only without being able to compare the types. Whether I am therefore right or not in identifying the species under examination with *Cypræa granti*, d'Arch. and Haime, I am unable to say; the general shape seems to agree very well, but neither from the description, nor from the figure can any inference be drawn whether in *Cypræa granti* a similar sharp keel separates the base from the upper surface, as observed in the specimens under description, or not. If this feature were absent in *Cypræa granti*, a new name should of course be given to the specimens from Burma. K. Martin describes under the name of *Cypræa everwijni*, a species which appears if not identical certainly closely related to the Burma species; the shape agrees very well; the aperture expanded at either end, the presence of the keel, separating base from upper surface seems to be the same, the only difference exists in the crenulation of the lips, and the partly visible spire of *Cypræa everwijni*; the first character may not be of great importance, though it is certainly very constant, but the second feature which is, however, not visible on the figure, would be of greater weight, inasmuch as in *Cypræa granti* the spire is always concealed.

Genus: ARICIA, Gray.

ARICIA HUMEROSA, Sowerby, spec., Pl. XIX, fig. 11, *a-c*.

1840. *Cypræa humerosa*, J. de Carle Sowerby, Transact. Geolog. Soc. of London, 2nd ser, 1840, Vol. V, pl. XXVI, fig. 27.

1853. " " d'Archiac and Haime, Descr. des Anim. foss du Groupe Num. de l'Inde, p. 331, pl. XXXII, figs. 8, 8a, 9, 10.

MEASUREMENTS.

Height	. 38·5 mm.
Width	. 30 "

The massive and thick shell is of moderate size and exhibits a triangular circumference which, by the slightly produced posterior canal, assumes a subpentagonal shape. The upper surface is strongly inflated, but somewhat flattened in the centre; it is provided with five strong tubercules varying in size. The most anterior one is rather long, but not very high, semilunar in shape and placed tranversely across the surface, turning its convex side in anterior direction. Behind it two rounded rather high tubercules are placed symmetrically on either side of the middle axis, and two smaller ones near the ambitus represent the posterior corners of the pentagon. The lower side is perfectly flat, the aperture central, rather narrow; apparently only the strongly inflated outer lip is externally set with a few coarse

transverse plications; inner lip inflated but apparently smooth. Anterior canal short, posterior canal turned upwards, fairly long and broad.

Geological occurrence.—
Zone of *Aricia humerosa,* Thayetmyo.

Remarks.—The specimen above described has remained the only one which has come under examination, but being well preserved, its characters could be satisfactorily fixed. Only the characters of the aperture remain somewhat doubtful, as it could not be ascertained whether it is crenulated on both sides or whether, as it appears, only the outer lip exhibits the transverse plications; if existing, they were certainly much weaker than those of the outer lip.

Aricia humerosa was first described and figured by J. de Carle Sowerby, but his specimen differs from that under description by having three separated tubercules placed in a semi-circle on the posterior part of the shell, instead of a single curved transverse ridge. The specimens which have been examined and described by Messrs. d'Archiac and Haime differ in a similar way from Sowerby's type, and they agree therefore better with the specimen from Burma. The question now arises, are we to see in this feature a different specific character, or is it nothing more than an individual variation. I rather feel inclined to take the latter view, since I have seen the number of varieties which *Aricia moneta* develops, but should it really form a distinctive specific character, the name of *Aricia sella,* d'Arch. and Haime, spec. should be substituted, because these authors already noticed this difference.

K. Martin describes under the name of *Cypræa murisimilis,* a species which is apparently closely related to *Aricia humerosa,* but he opines that being anteriorly much broader, it ought to be considered different from *Cypræa humerosa.* I do not know whether a slight difference, as the one mentioned, should constitute a specific difference, and I dare say Professor Martin would perhaps take this view if he were to examine a large number of *Aricia moneta,* which though none of the shells is exactly like the other, all represent one and the same species.

Considering that Professor Martin states that the arrangement of the tubercules on the surface is exactly the same in *Cypræa humerosa* and *Cypræa murisimilis,* and further that he himself thinks that *Cypræa murisimilis* holds in shape the middle between *Cypræa humerosa,* Sowerby, and *Cypræa humerosa,* d'Archiac and Haime, I believe that it would be better to consider both species as identical. My view is further supported by K. Martin's observation, that in one of his specimens the three anterior tubercules are amalgamated into one transverse ridge; Professor Martin attributes therefore little importance to this difference which he apparently took as only an individual variation. It is to be hoped that Professor Martin will, in his monograph on the Miocene Fossils from Java, state his reasons why *Cypræa murisimilis* should be distinguished from *Cypræa humerosa* more explicitly, because I think that both species had better be considered as identical for reasons above stated.

Aricia humerosa has apparently no living relative among the fauna of the Indian Ocean, and most probably represents an extinct type.

Genus: TRIVIA, Gray.

TRIVIA SMITHI, K. Martin, Pl. XIX, fig. 13, *a-e*.

1883—87. *Cypraea (Trivia) smithi*, K. Martin, Tiefbohr. auf Java, Beitr. zur Geol. Ost. Asiens und Australiens, 1st Ser., Vol. III, p. 141, pl. VIII, fig. 141.

MEASUREMENTS.

Height	10 mm.
Width	7·7 „
Height of apex of last whorl above base	6·4 „

The shell is of small size only, broadly elliptical in shape, slightly tapering towards either extremity, strongly inflated.

The upper surface is covered with a number of sharply raised, rather strong, transverse ribs of various length, taking their origin partly from the inner edge of the lips, partly from the edge of the canals; only a few ribs extend from either side as far as the apex of the upper surface, where they alternate, but do not amalgamate, being separated by a slight longitudinal furrow, because the majority of the ribs stop short before reaching the apex.

The base is slightly inflated, the inner lip considerably broader than the outer one; both, but particularly the outer lip, are strongly tumid and well set off against the upper surface by a sudden bend of the shell. Both lips are externally covered with about 10 to 11 sharp transverse ribs, separated by broad, concave interstices, taking their origin from the inner edge of the lips and extending towards the upper surface where they terminate as previously described.

Aperture eccentric, narrow but slightly expanded at either end.

Geological occurrence.—

Zone of *Paracyathus caeruleus*, Yenangyat.

Remarks.—There can be no doubt that the specimen under description is identical with *Cypræa (Trivia) smithi*, K. Martin, from Java, all the features being the same, at least I could not discover any difference with regard to either shape or ornamentation.

Tryon[1] states that there are 45 species belonging to this genus, one of which inhabits the northern seas of Europe; according to Reeve's monograph of the genus *Cypræa* most of them live nowadays in the Western Hemisphere, while only a small number live in the Indian Ocean, as far as the Philippine Islands. K. Martin thinks that there is some similarity with *Trivia onisca*, Lmk., spec., a view in which I cannot follow this author; not only is the ornamentation of this species considerably different, the ribs are more numerous, apparently fewer, and frequently bifurcate near the apex, but what appears to me more important still, is the great difference in the aperture which is wide and gaping in *Trivia onisca*, narrow and slit-like in *Trivia smithi*. The nearest relative of *Trivia smithi* seems to me *Trivia radians*, Lmk., from West Columbia which exhibits the same, rather small, number of strong ribs alternating but not joining at the apex of the whorl.

[1] Structural and Systematic Conchology, Part II, p. 198.

Trivia rubinicolor from the Indian Ocean is distinguished by a larger number of finer ribs which are not separated as in *Trivia smithi*, but join in the middle of the upper side. The number of ribs which stop short before reaching the apex of the upper side is much smaller in *Trivia rubinicolor* than in *Trivia smithi*. It is therefore obvious that whatever may be the nearest relatives of *Trivia smithi* it represents a type which is extinct among the fauna of the Indian Ocean.

Family: *CASSIDIDÆ*, Adams.

Genus: CASSIS, Lamarck.

CASSIS D'ARCHIACI, Noetling, Pl. XIX, fig. 14, *a-c*.

1853. *Cassidaria carinata*, d'Archiac and Haime, Descr. des Anim. Foss du Groupe Num. de l'Inde, p. 317, pl. XXXI, fig. 1.

1895. *Cassidaria d'archiaci*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, Vol. XXVII, p. 27, pl. VI, figs. 1, 1*a*, 1*b*.

MEASUREMENTS.

Height . .	27 mm.
Width . .	20 „

The shell is of small size, ovate, globose in shape, composed of a low, but elevated spire and a very high body whorl.

Embryonic whorls not observed.

The attenuated spire consists of about five whorls which increase very slowly in height, changing at the same time the angle which the surface forms with the suture; steeply inclined at the earlier whorls, the surface slopes more gently afterwards, the abovementioned angle changing from about 70° to 45°. The suture is not well marked, and the ornamentation consists of about four flat, somewhat irregular revolving keels, the most posterior of which (No. 4) is much stronger than the others; these keels are crossed by numerous, but somewhat irregular striæ of growth; there are a few irregularly distributed varices.

The body whorl is very large, strongly inflated and anteriorly slightly attenuated; its posterior part is slightly flattened and slopes gently towards the suture: it is this part of the shell only which is visible of the spire whorls. The revolving ornamentation is twofold, *viz.*, tubercules and flat keels; the whole surface is covered with flat keels of small but varying breadth which are separated by sharply engraved lines; three of these bands are broader than the others and are set with short, but strong, pointed tubercles; the striæ of growth which cross the revolving ornamentation are coarse, numerous but somewhat irregular.

The aperture is large, triangular in shape, posteriorly attenuated and anteriorly expanded; the outer lip is very thick, reflected, internally set with a number of coarse plications; the inner lip thin but expanded, set with a few spiral wrinkles, three of which are thick and strong, the most anterior one rudimentary, anterior canal rather long, narrow, recurved and ascending.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.

Remarks.—I originally considered this species as belonging to the genus *Cassidaria*, but having since compared it with living species, I think it is preferable to range it among the genus *Cassis*. The distinction of the genera *Cassis* and *Cassidaria* is based on such minute details, which are hardly observable in fossil species, that it will often be impossible to say to which of the two genera a given species belongs.

It is unquestionable that the species under description is identical with the fragment which has been described by Messrs. d'Archiac and Haime as *Cassidaria carinata*, Lam. var., though it is unquestionable that this species is different from the typical *Cassidaria carinata*, Lam., a view which was apparently held by Messrs. d'Archiac and Haime themselves, and which they gave expression by adding var. to their determination. If we compare the figures of this species as given by Deshayes the difference is at once apparent; *Cassidaria carinata* is distinguished by a more attenuated body whorl, set with about five revolving keels, of which only one or two are nodose; more important seems the longer anterior canal which is laterally curved and not recurved and ascending as in *Cassis d'archiaci*.

Though the genus *Cassis* is nowadays represented by numerous species, I have not been able to discover any one which might be compared to *Cassis d'archiaci*, but it is unquestionable that it belongs to the group of the well-known *Cassis cornuta*, Lin., which is characterised by a similar ornamentation and shape of the aperture, having an inner lip set with a few wrinkles only (*vide* Reeve's monograph of the genus *Cassis*, Pl. I, fig. 2), but a further relationship with this species is most probably out of question. It seems therefore very probable that *Cassis d'archiaci* represents a type which is extinct among the present fauna of the Indian Ocean.

Genus : SEMICASSIS, Klein.

SEMICASSIS PROTOJAPONICA, spec. nov., Pl. XIX, fig. 15, *a-c*.

1895. *Cassidaria dubia*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 27, pl. VI, figs. 2, 2*a*, 3.

MEASUREMENTS.

Height . .	17 mm. (approximately).
Width . .	14 „
Apical angle .	88°

The shell is of small size, ovate in shape, globose, consisting of a short elevated spire and a high strongly inflated body whorl.

Probably two smooth embryonic whorls.

The spire is short, turreted and well elevated, consisting of about four rounded whorls which slowly increase in height. The suture is rather deep. On the earlier whorls a few indistinct revolving keels begin to appear which gradually gain in strength; on the penultimate whorl these keels are rather sharp, slightly granulose and separated by broad concave interstices. No varices observed on the spire whorls.

The body whorl is large and strongly inflated; the ornamentation consists of strong, granulose revolving keels separated by broad interstices, which show a few filiform chords in such a way, that strong ribs and fine chords regularly alternate; opposite the outer lip is a strong varix. The outer lip is rather thick and reflected, apparently denticulate within. Anterior portion of the body whorl broken off, the canal therefore not observed.

Aperture not observed, probably rather wide.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.

Remarks.—There is no similar species among those described by Martin from Java, Sumatra and Western India, nor can I find any other fossil species to which *Cassis protojaponica* could be compared.

On the other hand it is unquestionable that it belongs to that group of which we may consider *Cassis japonica* as the type. This group is distinguished by a very simple ornamentation, consisting of numerous revolving keels which cover the whole of the surface of body and spire whorls. Varices are rare and there is generally one only on the body whorl, more or less opposite to the outer lip. The spire whorls do not exhibit any varices, and even that of the body whorl may be absent in individual specimens.

The specimens of *Cassis japonica*, Reeve, which I could compare, show a great similarity with *Cassis protojaponica*, yet there exist certain differences which render a specific identity impossible. It appears that *Cassis japonica* has a higher spire, and therefore a more acute apical angle than *Cassis protojaponica*. This feature will be seen best in the following table:—

	Apical angle.	Ratio of spire to total height.
Cassis japonica	76°	0·23
Cassis protojaponica	86°	0·20

It must however be mentioned that it appears that in *Cassis japonica* the apical angle, and therefore the height of the spire are subject to certain variations, as I have seen a specimen of *Cassis japonica* in the Indian Museum having quite a low spire. There exist certain differences with regard to the ornamentation between the two species which are best to be seen on the body whorl. In *Cassis japonica* the ornamentation consists of numerous flat revolving ribs of varying breadth separated by rather narrow interstices, the breadth of which is also subject to variation; only here and there a finer rib is interpolated between two stronger ones. In *Cassis protojaponica* the ornamentation consists of sharp, granulose ribs of equal strength separated by interstices of uniform breadth, and there is a very regular alternation of stronger ribs and finer chords, the latter appearing in the interstices.

If we turn, however, to the ornamentation of the spire whorls we observe an ornamentation very similar to that of *Cassis protojaponica*; the ribs are almost equidistant, of equal breadth and obscurely granulose, being separated by broad interstices. The granulose appearance is produced by fine somewhat oblique longitudinal lines, which at the point of intersection with the revolving keels are raised into fine nodules.

The brephic stage of *Cassis japonica* exhibits therefore such a great similarity with the fossil *Cassis protojaponica* that it is very probable that it has directly evolved from that species; larger size and a coarser ornamentation are quite in concordance with the same observations made in other species.

Genus : GALEODEA, Link.

GALEODEA MONILIFERA, spec. nov., Pl. XIX, figs. 16, 17, 17*a*.

MEASUREMENTS.

Height	22 mm.	16 mm.
Width	?	12·5 "
Apical angle	?	?

The shell is of small size only, elongate, ovate in shape, composed of a rather high spire and a large body whorl.

The spire is apparently composed of more than four inflated whorls, increasing rather quickly in height, which are separated by a deep suture. As far as can be seen, the ornamentation consists of a few rounded revolving keels separated by broad and flat interstices.

The body whorl is rather large, inflated and anteriorly attenuated, ending in a fairly long, laterally turned canal. The ornamentation consists of rounded revolving keels, separated by broad interstices in which a finer one appears; one of these keels is spinose and the surface slopes gently from it towards the suture. No varices observed. Aperture not observed.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.

Zone of *Meiocardia metavulgaris*, Singu.

Zone of *Arca theobaldi*, Kama.

Remarks.—There can be no doubt that the specimen under examination belongs to the genus *Galeodea;* the elevated spire and the fairly long anterior canal speak decidedly for such a view.

The specific characters have perhaps not been made out with desirable completeness; but the rather small size of the shell, together with its ornamentation, particularly the single nodose keel dividing the smaller posterior part of the surface of the body whorl from its larger anterior one, are features which are recognisable in all the specimens I examined.

Genus : ONISCIDIA, Swainson.

ONISCIDIA MINBUENSIS, Noetling, Pl. XIX, figs. 18, 18*a*, 19, 19*a*.

1895. *Cassidaria minbuensis*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 28, pl. VI, figs. 4, 4a, 4-5.

MEASUREMENTS.

Height	12·5 (approximately).
Width	?

The shell is of small size, volutiform in shape, consisting of a low turreted spire, and a high attenuated body whorl. Embryonic whorls not observed

The spire consists of about five whorls; the exact number could not be ascertained, the apex being damaged in all the specimens; the whorls are inflated, somewhat angular and separated by a deep suture. The earlier whorls appear to be rounded, but the penultimate whorl is divided by a revolving keel into a gently sloping posterior and an almost vertical anterior part.

The ornamentation could not be well observed, but it seems to consist of rather strong longitudinal ribs crossed by numerous revolving ribs, which are raised at the point of intersection into low nodules. No varices observed.

The body whorl is high, occupying almost two-thirds of the total height inflated, angular and strongly attenuated in anterior direction. The keel setting off the smaller posterior part, which gently slopes towards the suture, is well marked; the ornamentation consists of strong longitudinal ribs, apparently fading away towards the aperture, which are crossed by numerous rounded revolving keels separated by linear interstices.

The aperture was apparently rather long, but narrow; the outer lip is sharp, raised and covered internally with coarse wrinkles; the inner lip is large, expanded and set with numerous irregular coarse wrinkles. Anterior canal short, apparently laterally curved.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.

Remarks.—Though I have only a few, not very well preserved specimens before me, they are perfectly sufficient to fix the generic position. The raised spire, the short canal prove that we have to consider this species as a *Cassidaria* which differs by its smaller size, but particularly by the ornamentation, from *Galeodea monilifera.* I find neither a fossil nor a living relation of this species.

Family : *FICULIDÆ*, Deshayes.

Genus : FICULA, Swainson.

Ficula theobaldi, Noetling, Pl. XIX, figs. 20, 20*a*, 21, 21*a*.

1895. *Ficula theobaldi*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 28, Pl. VI, figs. 5, 5*a*.

Measurements.

Height	.	more than 40 mm.
Width	.	not measured.

The shell must have attained a considerable size, because a fragment of the body whorl measures not less than 40 mm. in height, though all the other specimens examined remain well under that size; it is pyriform in shape, composed of a short depressed spire and a very large anteriorly attenuated body whorl.

Embryonic whorls not observed. The spire whorls, which are about four in number, increase slowly in height, and are separated by a sharp suture; the earlier whorls are apparently rounded, but the penultimate whorl becomes decidedly angular, owing to two sharp revolving keels. The ornamentation consists of a

number of fine revolving keels, two of which are much stronger than the others, and divide the surface into three bands of about the same breadth; these keels are crossed by numerous fine, but sharply raised, regular equidistant longitudinal ribs producing a regular lattice work.

The body whorl is very large and high, broad and inflated at its posterior, attenuated, and somewhat flatter towards its anterior end. The lattice-like ornamentation is more distinct than on the spire whorls, and shows the following character; there are about 14 sharply raised, but fine revolving keels separated by broad interstices of the same breadth, each of which is sub-divided by a finer keel into two bands of equal breadth; each band bears again three still finer keels, the central one of which is perceptibly stronger than the two others. If the ribs are divided according to their strength into four orders, their sequence in antero-posterior direction would be as follows: 1st, 4th, 3rd, 4th, 2nd, 4th, 3rd, 4th, 1st order. The revolving ornamentation is crossed by numerous fine, but sharply raised longitudinal ribs of uniform strength following close to each other at about the same distance. A very characteristic lattice-work is thus produced by the intersection of the longitudinal ribs of equal strength and the revolving ribs of different strength. Aperture unknown, but apparently longitudinal and rather wide.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Meiocardia metavulgaris*, Singu.
Zone of *Cancellaria martiniana*, Minbu.
Zone of *Paracyathus caeruleus*, Yenangyat.

Remarks.—This species is easily distinguished by the peculiar lattice-work ornamentation as above described; in *Ficula* spec. the revolving ribs are almost all of equal strength, much more numerous and the meshes of smaller size. If the ornamentation as above described is a specific character and not subject to variations, I am unfortunately not in the position to settle this question, as only one specimen shows the surface sufficiently well preserved. *Ficula theobaldi* bears no similarity to any fossil or living species. A distant relative is perhaps *Ficula ficoides*, Brocchi, but I cannot say anything definite with regard to this species. It appears, however, certain that *Ficula theobaldi* represents a type which does not exist among the living fauna of the Indian Ocean.

FICULA, SPEC., Pl. XIX, figs. 22, 22*a*.

Unfortunately only a few fragments have been preserved, but the character of the ornamentation seems to demonstrate that the species here mentioned is different from *Ficula theobaldi*. The shell was apparently of still larger size and the ornamentation consists of numerous, very closely set revolving keels of equal strength; at least there is not much difference in strength, though some of the keels are a little finer than others; these keels are crossed by numerous, rather

fine, longitudinal ribs, which are of equal strength and closely follow each other; the lattice-work thus produced consists of numerous small meshes of equal size.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—The numerous revolving keels of almost uniform size, and the small meshes readily prove that the fragments above mentioned must belong to a species different from *Ficula theobaldi*. Owing to the very fragmentary state I have, however, refrained from giving a special name.

Family: *TRITONIDÆ*, Adams.

Genus: TRITON, Montfort.

On the following pages three species have been described which must be considered as belonging to the genus *Triton*, if in concordance with Reeve, we take this genus to be characterised by irregularly distributed varices; as, however, in two of the species there are probably not more than two varices to one volution, while in *Triton* there should at least be three, their generic position may appear somewhat doubtful.

These species can be easily distinguished as follows:—

A. Shell short.

(*a*) Body whorl covered with numerous fine revolving chords, separated by linear interstices.

1. *Triton neastriatulus*, spec. nov.

(*b*) Body whorl covered with a few rather strong revolving keels separated by broad interstices.

2. *Triton pardalis*, Noetling.

B. Shell elongate.

3. *Triton neacolubrinus*, spec. nov.

No living relatives of these species could be found, though I devoted considerable time to the study of the species of *Triton* and related genera, preserved in the collection of the Indian Museum. It can, therefore, be considered as certain that they represent types which do not exist among the living fauna of the Indian Ocean.

On the other hand, two species, *Triton neastriatulus* and *Triton neacolubrinus*, exhibit such a close relationship to *Triton striatulus* and *Triton colubrinus* from the Eocene of Paris, that, particularly with regard to the former species, it appears almost impossible to discover any differences.

The relationship of the third species, *Triton pardalis*, appears somewhat doubtful; in shape it is almost the same as the living *Triton gemmatus*, yet if this species would be considered as the descendant of *Triton pardalis*, just the opposite of the rule hitherto observed with regard to ancestor and descendant would take place. In all other instances where such a relationship could be traced, the living descendant exhibited a larger size and a coarser ornamentation. In this instance the size would have remained the same, but the ornamentation of the living species would

be much finer than that of its fossil ancestor. This being contrary to all the other observations, I believe that there exists no relationship between *Triton pardalis* and *Triton gemmatus*, and that the former represents an extinct type, which has most probably its nearest relatives among the fauna of the older Indian Tertiary.

Triton neastriatulus, spec. nov., Pl. XX, figs. 2, *a–c*, 3, 3*a*.

1895. *Triton pardalis*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, pl. VII, fig. 8*a* (non. 7, 7*a*, 8)!

Measurements.

Height . .	more than 18 mm.	approximately.
Width . . .	11 „	
Apical angle . .	55°	

The shell is of small size only, elongately ovate, composed of more than five whorls forming an elevated spire and comparatively short body whorl.

Embryonic whorls not observed.

The spire is composed of at least four, strongly inflated whorls separated by a very deep suture; the whorls, which increase very slowly in height, are covered with a few thick rounded longitudinal ribs, of which there are eight to one volution, separated by broad interstices, those of the succeeding whorl following straight underneath of those of the preceding one; there are a few varices which differ so little in strength from the longitudinal ribs that they are hardly discernible. The whole surface of the whorls is covered with numerous smooth and flat, revolving keels, somewhat irregular in strength, separated by deeply engraved linear interstices. The longitudinal ribs begin to become weaker on the penultimate whorl and have entirely disappeared on the body whorl, where only the varices remain.

The body whorl is rather short and covered only with the revolving ornamentation, but the keels have increased in strength, the interstices have become broader, and towards the anterior end a fine filiform line appears between two stronger keels. The last varix is of great thickness, strongly inflated and well set off against the other part of the surface by a deep furrow at its posterior side; the revolving ornamentation extends all over its surface, as well as on the external side of the outer lip.

The aperture is oval, but rather small, being restricted by the broad varix; the outer lip is sharp, raised; the inner lip thin, covering the columella, but slightly raised at its anterior end. The anterior canal is short, narrow and strongly turned upwards.

Geological occurrence.—

Zone of *Paracyathus caeruleus*, Yenangyat.

Remarks.—This species is very similar to *Triton pardalis* with which I identified it in my first memoir; having since obtained somewhat better preserved specimens, I must admit that fig. 8 of my previous memoir, which I have taken as the type of *Triton neastriatulus*, differs from the other figures, for which I retain the name of *Triton pardalis*.

The shape of both species is much the same, but the ornamentation exhibits some

differences not to be overlooked; in the *Triton neastriatulus* the longitudinal ribs of the spire whorls are few, but they are rather strong; in *Triton pardalis* they are numerous and thin; the chief difference rests, however, in the revolving ornamentation, particularly as it is observed on the body whorl; in *Triton neastriatulus* it consists of numerous but somewhat irregular revolving keels separated by linear interstices; in *Triton pardalis* the keels are rather regular and separated by broad interstices which are occupied by very fine filiform keels. In addition it may be mentioned that in *Triton pardalis* the last varix is never so broad and strongly developed as in *Triton neastriatulus*, particularly the deep furrow at its posterior side is absent in *Triton pardalis*.

The generic position of *Triton neastriatulus* may appear somewhat doubtful, because, as far as I can make it out, there do not exist more than two varices to one volution; it is, however, extremely difficult to distinguish between varices and longitudinal ribs on the earlier spire whorls; in fact none of the specimens I examined allows the distinction between varices and longitudinal ribs to be carried out beyond the penultimate whorl; it is, however, quite certain that there are only two varices opposite each other on the body and penultimate whorl; and in one specimen they are arranged in a straight line, while in the other they unquestionably do not show this *Ranella*-like arrangement. Taking everything into consideration I should think that the specimens under examination should rather be included among the genus *Triton* than among the genus *Ranella*.

No similar species is known either from Java, Sumatra or Western India, nor can I find any living relative, and we must assume that *Triton neastriatulus* represents a type which does no longer exist among the living fauna of the Indian Ocean.

On the other hand it bears the strongest relationship to *Triton striatulus*, Lmk. sp., from the Eocene of Paris. The only difference between *Triton striatulus* and *Triton neastriatulus* exists with regard to the longitudinal ribs, which in the Eocene species are still strongly developed on the body whorl, while in *Triton neastriatulus* they begin to die out on the penultimate whorl, and have entirely disappeared on the body whorl.

The fact that *Triton neastriatulus* has no living relation in the fauna of the Indian Ocean, while it bears a strong relationship to the Eocene *Triton striatulus*, Lmk., is a very interesting one, as under these circumstances this species represents an archaic element.

TRITON PARDALIS, Noetling, Pl. XX, fig. 5, *a-c*.

1895. *Triton pardalis*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1896, Vol. XXVII, pl. VI, figs. 7, 7*a*, 8 (non. 8*a*)!

MEASUREMENTS.

Height	.	15 mm. (approximately).
Width	.	9 „
Apical angle	.	58°

The shell is of small size, bucciniform in shape, composed of an elevated turreted spire and a rather short body whorl.

Embryonic whorls not observed.

The spire consists of more than four rounded whorls, separated by a deep suture, increasing gradually in height. The ornamentation consists of thin longitudinal ribs, which are rather numerous; there may be 18 to one volution, separated by rather narrow interstices; the varices are low and not very distinctly seen, but there appear to be three to one volution. The revolving ornamentation which covers the whole surface consists of numerous fine, flat keels, separated by broad interstices which are filled up by filiform raised lines, one of which sometimes exceeds the others in strength.

The body whorl is inflated, appearing rather short, though it occupies over half of the total height; it is perfectly free of any longitudinal ornamentation; in fact the ribs grow already weaker on the penultimate whorl; the revolving ornamentation is the same as on the spire whorls, only more distinct, and some of the secondary keels become almost as strong as the primary ones. The last varix is rather strong, inflated and covered with the revolving keels and intermediate lines.

The aperture is oval, rather wide; the outer lip sharp but apparently only a little raised; inner lip thin, covering the short columella. Anterior canal short, slightly bent upwards.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.
Zone of *Paracyathus caeruleus*, Yenangyat.
Zone of *Arca theobaldi*, Kama.

Remarks.—As I already remarked I originally united *Triton neastriatulus* with this species; a closer examination of better preserved specimens has, however, proved that this view is untenable, and as the differences have been explained in the description of *Triton neastriatulus*, it is superfluous to repeat them here.

No similar species has been described from either Java, Sumatra or Western India, and I find also no other fossil species to which I could compare it.

Among the living species *Triton gemmatus*, Reeve, appears at the first moment very similar to *Triton pardalis*, but on closer examination it will be seen that though in shape they are almost the same, the ornamentation is perfectly different. In *Triton pardalis* the ornamentation consists of numerous fine revolving ribs, the interstices of which are occupied by extremely fine chords, in *Triton gemmatus* there are a few, coarse and strong revolving ribs, which are separated by neatly cancellated interstices, having however only one, or, at the outside, two revolving chords.

This similarity in the shape will be best expressed by the following table:—

	Total height.	Height of the spire.	Ratio between total height and height of the spire.	Apical angle.
Triton pardalis . . .	15 mm.	6·5 mm.	0·43	58°
Triton gemmatus . . .	15 „	5·5 „	0·33	58°

From these figures it appears that the only difference which can be made out concerns the relative height of the spire, which appears to be slightly higher in *Triton pardalis* than in *Triton gemmatus*.

Whether under these circumstances *Triton gemmatus* can be considered as a descendant of *Triton pardalis* I am unable to say; in fact I rather feel inclined to reject such a view on account of the almost absolute similarity of shape. In all the other species which could be considered as the ancestors of living species we have seen that there is a general tendency towards the development of larger size and coarser ornamentation from the fossil to the recent species. In the present instance the size would have remained the same, but the ornamentation would have become finer in the living descendant. For these reasons I think that the similarity of both species is merely outwardly and not founded in any actual relationship, and that *Triton pardalis* represents a type which is extinct among the fauna of the Indian Ocean.

TRITON NEACOLUBRINUS, spec. nov., Pl. XX, fig. 4, *a-d*.

MEASUREMENTS.

Height	25·0 mm.
Width across the aperture .	12·0 „
Apical angle . . .	40°

The shell is of small size only, elongately turreted and composed of nine rounded whorls which form an elevated spire, and a comparatively low body whorl.

Embryonic whorls not observed.

The spire is composed of not less than eight rounded whorls very gradually increasing in height, which are separated by a deep suture and form a high spire. The ornamentation consists of equidistant longitudinal ribs, which are rather sharp at the earlier whorls, but become more rounded afterwards; the ribs and interstices are covered with numerous fine revolving keels, which, when crossing the ribs, swell up to flat nodules; the varices are rather thick, and there are about three to one volution.

The body whorl appears rather short in comparison with the elevated spire; nevertheless it forms about half of the total height; it is strongly inflated, attenuated and truncated anteriorly. The ornamentation is the same as on the spire whorls, only that it becomes stronger, and that a finer line appears in the interstices between the stronger keels.

The aperture is rather small, obliquely oval; the outer lip sharp, raised, externally covered with the revolving keels and lines, internally coarsely plicate; inner lip thin, covering the short columella; no posterior canal; anterior canal very short, bent upwards.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Remarks.—The elongated shell with its high spire and the strong longitudinal ribs readily distinguish this species from *Triton pardalis*.

No similar species has been described from either Java, Sumatra or Western India, neither can I find any relative among the fauna at present inhabiting the Indian Ocean.

On the other hand, it bears the greatest relationship to *Triton colubrinus*, Lmk., from the Eocene of Paris. Shape and ornamentation agree so well that it seems difficult to discover any differences. The only difference which I can discover consists in the ornamentation of the body whorl; in *Triton neacolubrinus* the longitudinal ribs extend all over the surface, right up to the end of the canal, while in *Triton colubrinus* they are restricted to the posterior part of the surface, and the anterior part is free of them.

Triton neacolubrinus represents, therefore, an archaic type, having its nearest relative in the Eocene, and has disappeared in the present fauna of the Indian Ocean.

Genus: PERSONA, Montfort.

Though only a single specimen has come under examination, the distorted spire in connection with the varices proves unquestionably the generic position, though the aperture apparently differs considerably from that of the living *Persona anus*.

So far as I can say *Persona gautama* represents unquestionably an extinct type which has neither any fossil nor living relatives, the ancestors of which will most probably be found among the fauna of the Indian Eocene.

PERSONA GAUTAMA, spec. nov., Pl. XX, figs. 6, *a-e*, 7, 7*a*.

MEASUREMENTS.

Height	. 35 mm. (approximately).
Width	. 26 „
Apical angle	35° (approximately).

The elongate shell, which is of a small size, exhibits a peculiar distorted appearance; it is composed of a rather high spire and a moderately high body whorl.

Embryonic whorls not observed.

Only three spire whorls are preserved, but there were unquestionably more, perhaps not less than six; the whorls are rounded, increasing slowly in height and growing in a peculiarly irregular way, a curious distorted spire is produced instead of the regular one, observed in other gastropods. The suture is well marked, irregularly undulating. The ornamentation consists of strong, rounded longitudinal ribs, which can hardly be distinguished from the old varices; the ribs are separated by broad concave interstices. The whole surface is covered with numerous, fine revolving keels, separated by rather broad interstices.

The body whorl which occupies about half of the total height is posteriorly inflated, contracted and somewhat truncated in front. Its chief feature is the curious mode of growth by expanding in height towards the aperture, thus enveloping at least half of the penultimate whorl. The ornamentation undergoes also a change; the longitudinal ribs become more compressed, at the same time they are raised into short spines. The revolving ornamentation remains the same as on the spire whorls. The aperture is elongate; broad at the posterior end, tapering

in anterior direction; the outer lip is thick, strongly crenulated; the inner lip rather thick but well set off from the columella. Posterior canal short, slit-likee, anterior canal elongate, recurved and ascending, slightly expanded at the anterior end.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Remarks.—The curious distorted shape readily distinguished this species from all the others.

I have not been able to discover any relative, living or fossil, of this genus which most probably represents an extinct type.

Genus: RANELLA, Lamarck.

Two species, *Ranella prototubercularis* and *Ranella elegans*, have come under examination which can be easily distinguished as follows:—

A. Shell small; surface covered with numerous smooth revolving keels.
   1. *Ranella prototubercularis*, spec. nov.

B. Shell large; surface bearing a row of strong spines.
   2. *Ranella elegans*, Beck.

Though a most careful examination failed to discover any differences between the living *Ranella elegans* and its fossil representative, it is unquestionable that *Ranella prototubercularis*, though bearing the greatest similarity to the living *Ranella tubercularis*, represents the permanent neanic stage of that species.

Ranella prototubercularis, spec. nov., Pl. XX, figs. 8, *a-d*, 9, *a-d*.

1853 (?). *Ranella viperina*, d'Archiac and Haime, Descr. des Anim foss. du Groupe Num. de l'Inde, p. 310, pl. XXX, fig. 2.

1879-80 (?). *Ranella junghuhni*, Martin, Die Tertiärschichten auf Java, p. 54, pl. X, fig. 2.

1881-82 (?). *Ranella raninoidis*, Martin, Tiefbohr. auf Java Beitr. z. Geol. Ost. Asiens und Australiens, 1st ser., Vol. I, p. 203, pl. IX, fig. 6.

MEASUREMENTS.

Height . .	23·5 (approximately).
Width . .	12·7 "
Apical angle .	65°

The shell is of small size, sub-elongate in shape, composed of more than six whorls, which form an elevated spire and a large body whorl.

Embryonic whorls not observed.

As the apex is broken off, the exact number of the spire whorls could not be ascertained, but there were certainly more than five; the whorls are rounded and separated by a deep suture, forming an elevated spire which occupies about half of the total height. The ornamentation consists of three well raised rounded revolving keels, Nos. 2 and 3 of which are separated by a wider interstice than Nos. 1 and 2, the latter being slightly stronger than the others; the interstices are occupied by one, sometimes two, filiform revolving lines, the revolving keels are

crossed by filiform longitudinal ribs which at the point of intersection are raised into granular tubercules. There are two varices, opposite each other, on each whorl, which form a straight line, but sometimes the varix of the younger whorl is slightly in front of that of the preceding one. The varices are rounded and the revolving keels pass over them, being slightly thickened at the edge.

The body whorl is large, inflated, slightly oblique, tapering in anterior direction, and occupies at least half of the total height. The ornamentation is the same as that of the spire whorls, No. 2 keel being particularly strongly developed; in front of No. 1 there are about nine revolving keels, gradually decreasing in strength in anterior direction, finer filiform keels are visible in the interstices; the longitudinal ribs have become much stronger, while the tubercules at the point of intersection are less distinct. The last varix is high and thick, and crossed by the revolving keels, which apparently extend on the external side of the outer lip. The aperture is longitudinal in shape, rather small and narrow; the outer lip is sharp, raised, inner lip not seen; the columella is short, covered with fine spiral striæ, anterior canal short, slightly bent upwards.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.
Zone of *Paracyathus caeruleus*, Yenangyat.
Zone of *Arca theobaldi*, Kama.
Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—This species varies a good deal in the arrangement of the varices, and the development of the ornamentation. In some specimens the longitudinal ribs attain already a great thickness on the penultimate whorl, and the peculiar tuberculated squares of the earlier spire whorls have entirely disappeared; the revolving keels may become rather broad and flat, while at the same time the filiform lines in the inner interstices gain in strength and form regular keels, particularly on the edge of the last varix of the body whorl.

It does not seem doubtful that the species under description is identical with Messrs. d'Archiac and Haime's *Ranella viperina*, though on comparison of the figures, differences seem to exist. Messrs. d'Archiac and Haime's figure shows a specimen with delicate longitudinal ribs, even on the body whorl, while the revolving ribs are of uniform strength and do not exhibit that peculiar difference of strength by which No. 2 keel is much stronger than the others, and which is a characteristic feature of the species examined by me. The intermediate lines seem also to be less conspicuously developed, as not even a trace is shown in the figure. As the description is also silent on this point, I am unable to form any definite opinion, though, as it is already stated, it is very probable that *Ranella viperina* is identical with *Ranella prototubercularis*.

Ranella junghuhni, K. Martin, from Java is another species which appears to be, if not identical, very closely related to *Ranella prototubercularis*, and in my former memoir I expressed an opinion as to their identity. On closer examination

I think, however, to discover certain differences which I cannot allow to be overlooked; *Ranella junghuhni* has a larger number of revolving keels on the spire whorls, at least fig. 2*b* shows 5, while in *Ranella prototubercularis* constantly 3, in very rare instances 4, are to be seen.[1] The longitudinal ribs seem never to attain the strength of those of *Ranella prototubercularis*, and no trace of the fine intermediate lines is indicated in the figure of *Ranella junghuhni*.

As already stated *Ranella prototubercularis* is subject to a considerable variation with regard to the strength of its ornamentation, and it may be that the differences which seem to exist between this species and *Ranella junghuhni* should not be considered more than a local variation. The question can only be decided by a comparison of both species, and for the present I think it better not to identify the two species.

The same argument applies therefore also to *Ranella raninoides*, which Professor Martin himself considers to be different from *Ranella junghuhni*, though the difference is so slight that it fully comes within the compass of individual or local variation. According to Martin only the more regular lattice-like ornamentation distinguishes *Ranella junghuhni*, a feature on which I would not put too much stress, because, as I have pointed out above, the ornamentation of *Ranella prototubercularis* is subject to a good deal of variation, and the same may also be the case with *Ranella junghuhni*.

Having compared the fossil specimens with the living *Ranella tubercularis*, I can state with certainty that there is no difference with regard to the deciding specific features, yet the living representative exhibits certain characters which have not been observed in the fossil specimens. The living *Ranella tubercularis* attains unquestionably a larger size, the size of the fossil one being about that of the former, if the body whorl were removed. There is, however, another remarkable feature with regard to the ornamentation, the earlier spire whorls [2] show exactly the same ornamentation as described in the fossil specimens, but the number of the longitudinal ribs becomes suddenly reduced to two with the completion of the penultimate whorl, and the same feature continues on the body whorl.

The living *Ranella tubercularis* is therefore in its neanic stage exactly like the fossil *Ranella tubercularis*, but develops new specific features in the brephic stage. Under these circumstances I think it better to distinguish the fossil specimens by a new name, though it cannot be considered anything else but the permanent neanic stage of *Ranella tubercularis*.

The above considerations give rise to a question of priority in nomenclature; if the species under description would be identical with *Ranella viperina*, d'Archiac and Haime, this name ought to be given to it, according to the rules of priority, and if it was not identical with this species but with either *Ranella junghuhni* or *Ranella raninoides*, the same would apply to these species, yet I think these names

[1] The same feature, *viz.*, three revolving keels, is observed on the spire whorls of the living *Ranella tubercularis*.

[2] There are three perfectly smooth embryonic whorls, strongly inflated and quickly increasing in height; the ornamentation commences with the fourth whorl, and almost at once shows its characteristic features; the first varix appears on the fourth whorl opposite the commencement of the ornamentation.

might give way to one which better expresses the relationship of the species under examination. It is almost a matter of personal opinion whether the species here described should be called *Ranella tubercularis* or *Ranella prototubercularis*, particularly as it has not been proved yet that no specimens occur together with those representing the neanic stage, which exhibit the features of a full grown *Ranella tubercularis*. The possibility that I had only adolescent specimens under examination cannot be denied, yet it does not seem very probable to me, and I prefer to regard *Ranella prototubercularis* as the permanent neanic stage of *Ranella tubercularis*. As under these circumstances *Ranella prototubercularis* can only be considered to represent an evolutionary stage of *Ranella tubercularis*, the question might well be asked, is it advisable to distinguish it by a new name. This is, as already said, a matter of personal opinion, if it should be held that the Miocene ancestor of a living species, which is represented by the brephic stage of that species, ought to be distinguished under a special name, as I do, the specific name "*prototubercularis*" is fully justified ; if this view is not shared, the specific name "*tubercularis*" must naturally supersede all the other names, always provided that these species are identical with the one here described.

As already stated, I hold the former view, yet I would consider it absurd to call the neanic stage of a certain species "*viperina*" and the ephibic stage of that same species "*tubercularis*", a logical consequence if the rule of priority were strictly upheld. Supposing we had a large number of specimens of *Ranella tubercularis* in all stages of age, would it not be considered as absurd to distinguish those representing the neanic stage under an absolutely different specific name, though it may perhaps be permitted to consider these same specimens under a name which indicates the close relationship with the full-grown species, when such types occur in a geologically older formation. I think for these reasons that it is preferable to adopt the specific name "*prototubercularis*" even if it were eventually proved that this species is identical with *Ranella viperina*, d'Archiac and Haime.

RANELLA ELEGANS, Beck, Pl. XX, fig. 10, *a-b*.

1844. *Ranella elegans*, Reeve, Monograph of the Genus *Ranella*, pl. V, fig. 22.
1879. „ „ Martin, Tertiär. auf Java, p. 55, pl. X, fig. 3.

MEASUREMENTS.

Height .	35 mm.
Width .	24 „ (across varices).
Apical angle	65°

The ovate shell is of moderate size composed of more than seven whorls forming an accuminate spire, and a large anteriorly attenuated body whorl.

Embryonic whorls not observed.

The elevated and accuminated spire consists of six whorls, gradually increasing in height and separated by a deep suture ; the earlier whorls appear to be rounded, but the later ones become angular, sloping from a revolving keel in anterior and posterior direction. The ornamentation consists of numerous fine granulated revolving keels, one of which becoming very soon stronger than the others, is composed of strong, pointed spines ; every half volution a strong, sharply raised spinous

varix is formed, joining those of the preceding and succeeding whorls, so that a continuous varix runs on the outer side, from the apex to end of the posterior canal, and exactly opposite to it on the inner side, another one runs from the apex to the posterior end of the aperture. The inflated body whorl is rather large, occupying more than half of the total length, and exhibits the same ornamentation as the spire whorls.

The aperture is not well seen as it is apparently damaged; the outer lip was probably thin, the inner lip thick, completely covering the columella; anterior canal short.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.
Zone of *Aricia humerosa*, Thayetmyo.
Zone of *Cytherea erycina*, Prome.

Remarks.—The best preserved specimen is unfortunately somewhat rolled, so that the finer ornamentation has become effaced, but there are still some traces left; another specimen from the zone of *Cytherea erycina* shows distinctly the finer granulated keels, though otherwise it is less well preserved than the former.

The shape, the character of the ornamentation prove that the specimen under examination is unquestionably identical with *Ranella elegans*, K. Martin. I have further been able to compare it with the living *Ranella elegans*, Beck, from the Indian Ocean, but though the living specimen is somewhat larger, it agrees in all principal characters with the fossil species. The shape of the shell is exactly the same; the apical angle measures 65° in the fossil, 68° in the living specimen, a difference which can certainly be disregarded. Still more important is the similarity of the ratio between the total height and the height of the spire; in the fossil species this ratio is 0·30, in the living one 0·29, as the ornamentation is also exactly the same, there can be no doubt of the identity of the fossil specimen with *Ranella elegans*, Beck, from the Indian Ocean.

Ranella morrisi, d'Archiac and Haime, exhibits a certain similarity with *Ranella elegans*, and it is perhaps probable that both species are identical, a view which can, however, only be proved after the type of *Ranella morrisi* has been examined, as figure and description of that species are equally defective.

3. RHACHIGLOSSA, Troschel.

Family: *BUCCINIDÆ*, Adams.

Genus: EBURNA, Lamarck.

Eburna protozeylanica, spec. nov., Pl. XX, figs. 11, 11*a*.

Measurements.

Height . .	30 mm.
Width . .	16·8 „
Apical angle .	60°

The shell is of moderate size, elongated bucciniform, composed of more than six whorls, forming an elongated spire and a large body whorl.

Embryonic whorls not observed.

The spire, which occupies slightly over one-third of the total height, is composed of not less than five inflated smooth whorls separated by a very deep suture.

The body whorl rapidly increases in height and forms about two-thirds of the total height; it is moderately inflated, and perfectly smooth, like the spire whorls, except numerous fine longitudinal striæ of growth which become here a little more visible. The aperture could not be well observed because the outer lip is broken off; it seems that it was elongated rather large; there is a distinct, though rather narrow posterior canal and a short broad anterior one. The inner lip is rather thick at the posterior part, thin and cutting anteriorly; the umbilicus is large and broad, posteriorly lined by a broad and flat band, which is well set off against the other part of the shell by a sharply engraved line. A sharp and well raised spiral fold runs up the umbilicus.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.
Zone of *Cytherea erycina*, Prome.

Remarks.—Martin describes three species from Java, from all of which *Eburna protozeylanica* is easily distinguished; *Dipsaccus canaliculatus* and *Dipsaccus pangkaënsis* have a much shorter thickly set shell, particularly a much shorter spire; *Dipsaccus gracilis* appears to be still more elongated than *Eburna protozeylanica*, so that with regard to the shape of the shell this species would be intermediate between *Dipsaccus pangkaënsis* and *Dipsaccus gracilis*, but rather nearer the former than the latter. In fact *Dipsaccus pangkaënsis* seems to be very closely related to *Eburna protozeylanica* particularly as the character of the aperture and the umbilicus seem almost the same, the only difference exists with regard to the umbilical plait. Martin states that it is subdivided by a deep furrow; no trace of such a furrow is seen on *Eburna protozeylanica*, where it appears to be perfectly smooth. On the other hand, it must be remarked that the specimen under examination is unquestionably somewhat rolled and the finer structural features of the umbilical plait may therefore have become effaced. Among the living species *Eburna zeylanica*, Lmk., agrees so well with this species in the general elongated shape of the shell, the non-canaliculated sutures and the characters of the aperture and the umbilicus, that I have not the slightest doubt that *Eburna zeylanica* is the direct descendant of *Eburna protozeylanica*, from which it is only distinguished by a larger shell attaining about $2\frac{1}{2}$ times the size of its fossil ancestor.

Family: *FUSIDÆ*, Tryon.

Genus: FUSUS, Lamarck.

The genus *Fusus* which in other Tertiary beds is generally represented by a number of species has yielded only two species, one of which may even be

considered somewhat doubtful with regard to its specific determination. The two species can be distinguished as follows :—

A. Shell small, aperture not expanded.
 1. *Fusus seminudus*, spec. nov.
B. Shell large, aperture expanded.
 2. *Fusus verbecki*, K. Martin.

No living relative of either species could be discovered among the fauna of the Indian Ocean, and both seem to represent extinct types; on the other hand, *Fusus seminudus* has apparently a very close relative in *Fusus conjunctus*, Desh., from the Paris Eocene, while *Fusus verbecki*, K. Martin, seems to be an indigenous type which has hitherto only been known from the Miocene of Java and Burma.

FUSUS SEMINUDUS, spec. nov., Pl. XX, figs. 12, *a-b*, 13, *a-b*.

1895. *Fusus (Clavella) djocdjocartæ*. Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 33, pl. VII, figs. 5, 6, 7, 7*a*.

MEASUREMENTS.

Height	. 30 mm. (approximately).
Width	. 11·5 mm.
Apical angle	. 27°

The shell is of moderate size, sub-fusiform and composed of at least seven whorls, forming a high accuminate spire and a large anteriorly contracted body whorl.

Embryonic whorls not observed.

The spire consists of at least six flat whorls, rather quickly increasing in height, separated by a sharp undulating suture. On the earlier whorls thick rounded longitudinal ribs, of which there are five to one volution, separated by broad interstices, are distinctly visible; these ribs become flatter and more indistinct on the later whorls, and on the penultimate whorl they are just traceable by the slight undulation of the surface. They are crossed by numerous revolving keels, separated by linear interstices, rather raised on the earlier, but flat on the later whorls; on the penultimate whorl they are represented by flat bands of varying breadth, separated by deeply engraved linear interstices.

The body whorl is rather high and occupies more than half of the total length, posteriorly it is broadly inflated, and suddenly contracting, it terminates in a long anterior canal. The longitudinal ribs have entirely disappeared and the surface is perfectly free of them; there are, however, two sets of revolving ornaments separated by a broad, perfectly smooth band; the posterior group consists of about eight to nine flat keels of varying breadth, separated by sharply engraved linear interstices; this group corresponds to the revolving keels seen on the spire whorls; the anterior group which is limited to the contracted portion consists of numerous closely set flat, rounded keels of unequal strength, separated by linear interstices.

The aperture is rather small, elongated, and terminates in a short posterior, and a long and narrow anterior canal; outer lip sharp, but thick; inner lip thick, covering the columella.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.

Zone of *Paracyathus caeruleus*, Yenangyat.

Remarks.—In my first memoir I identified this species with *Fusio djocdjocartae*, K. Martin, but I think it preferable to distinguish it under a separate name. There is no doubt that this species is closely related to *Fusus seminudus*, but as the type is represented by a rather fragmentary specimen of very indifferent character, I think it better to separate the species from Burma under a different name.

Fusus seminudus has apparently no living relatives among the fauna of the Indian Ocean, and probably represents an extinct type. *Fusus conjunctus*, Des., from the Eocene of Paris appears to be a near relative, having apparently the same ornamentation of the spire whorls, but this species unquestionably differs by a larger size and a much longer canal.

FUSUS VERBECKI, Martin, Pl. XX, figs. 14, 15.

1879-80. *Strombus* (?) *fusus*, K. Martin, Tertiär. auf Java, p. 50. pl. IX, figs. 9, 9a.

1895. *Fusus* (*Clavella*) *verbeeki*, K. Martin, Die Foss. von Java, p. 85, pl. XII, figs. 188-192, pl. XIII, figs. 193-198.

The only two specimens which have come under examination are rather fragmentary; correct measurements could not be taken, but it seems that the shell attained a considerable size, one specimen measuring about 38 mm. in length, the other 25 mm. in width.

The shell is apparently fusiform in shape being composed of a rather short turreted spire and a large body whorl, strongly contracted in anterior direction.

Embryonic whorls not observed.

Only three flat spire whorls, which are separated by an undulating suture, are preserved; the ornamentation consists of broad, but low, rounded longitudinal ribs which become weaker, and have perfectly disappeared on the penultimate whorl; these ribs are crossed by fine flat revolving keels separated by interstices of varying breadth; the keels become gradually effaced and on the penultimate whorl only a few close to the posterior suture are visible.

The body whorl is very large, broad and inflated posteriorly, suddenly contracted and terminating in a rather long and thick canal. There is no ornamentation on the posterior part, except numerous fine and closely set striæ of growth, but the anterior part is from the point of contraction covered with low, rounded revolving keels separated by linear interstices.

Aperture not well observed; it is, however, certain that the outer lip is rather thick and the posterior end broadly expanded.

Geological occurrence.—

Zone of *Aricia humerosa*, Thayetmyo.

Remarks.—Though the specimens which I examined are very poorly preserved, they still exhibit the characteristic shape of the aperture, with its thickened and

broadly expanded posterior end. I have, therefore, no doubt that it is identical with the above-named species from Java.

I cannot help thinking that *Strombus* (?) *fusus*, K. Martin, from Java is identical with *Fusus verbecki*, though Professor Martin does not mention this species in his description of the last-named species; the general shape of the shell, its ornamentation, but particularly the expanded posterior part of the aperture are so exactly alike in both species, that it would seem strange if two species which exhibit such a great similarity should really belong to different genera. It is to be regretted that Professor Martin did not discuss in his description of *Fusus verbecki* the strange similarity this species bears to his *Strombus* (?) *fusus*. I may be mistaken in my view, but if so the coincidence in the shape of *Fusus verbecki* and *Strombus* (?) *fusus* would be very strange.

Genus: FASCIOLARIA, Lamarck.

FASCIOLARIA NODULOSA, J. de Carle Sowerby, spec., Pl. XX, figs. 16, 17, 17*a*; Pl. XXI, fig. 1, *a-b*.

1840. *Fusus nodulosus*, J. de Carle Sowerby, Transact. Geolog. Soc. of London, 2nd ser., Vol. V, pl. XXVI, fig. 14.

1895. *Fasciolaria nodulosa*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 34, pl. VIII, figs. 1, 2, 3, 3*a*.

MEASUREMENTS.

Height	40 mm.	approximately.
Width	13 „	approximately.
Apical angle	43°	

The shell is of moderate size, fusiform in shape and composed of a high elevated spire and a large anteriorly contracted body whorl.

Embryonic whorls not observed.

There are only four spire whorls preserved, but there were probably not less than six; the whorls, which are rather ventricose, increase quickly in height and are separated by a strong undulating suture. The ornamentation consists of about six to eight thick, rounded, longitudinal ribs, separated by broad concave interstices. The whole surface is covered with moderately strong revolving keels, separated by interstices of about their own breadth; on the anterior part the keels are very regular and equidistant; on the posterior part, which is slightly concave, they become somewhat irregular and are separated by broader interstices in which sometimes a fine line appears.

The body whorl is rather large, its posterior part is strongly ventricose, the anterior one suddenly contracted, forming a long canal. The ornamentation is the same as on the body whorl, except that in some specimens the longitudinal ribs become weaker while the striæ of growth are more prominent. The revolving keels become also stronger, particularly those on the anterior part which are raised and absolutely granulose.

Aperture not well seen, but apparently oval; inner lip rather thick, well set

off against the columella; there are several columellar plaits which are, however, not very well seen, though there can be no doubt as to their existence.

Anterior canal very long and narrow.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.

Zone of *Paracyathus caeruleus*, Yenangyat.

Remarks.—The generic position of this species is proved by the existence of the columellar plaits of which there cannot be any doubt though they are not very distinctly seen.

The identity of the species here described with Sowerby's species is almost certain though the figure and description he gives are very defective.

Among the living species *Fasciolaria filamentosa*, Lam., from Ceylon seems to be a close relative, though this species seems to differ by a larger size, and the revolving ornamentation, which in the fossil species is not as in the living one, arranged in pairs.

Genus: PYRULA, Lamarck.

The three species here described belong all to the sub-genus *Melongena*, Schum., and can be easily distinguished as follows:—

A. Body whorl with only one row of spines near the suture.
  1. *Pyrula pugilina*, Born., spec.

B. Body whorl with two rows of spines, one near the suture, the other close to the anterior end.
  (*a*) Spire low.
    2. *Pyrula bucephala*, Lamarck.
  (*b*) Spire elevated.
    3. *Pyrula pseudobucephala*, spec. nov.

The specific independence of the last named species may perhaps be questioned, as it is quite possible that if a larger number of species could be compared, a gradual passage between high and low spired shell could be proved. Yet the few specimens which I examined are so distinctly divided into specimens with a high and low spire, that it was necessary to separate them under a different name.

Pyrula (*Melongena*) *pseudobucephala* would therefore represent the extinct Miocene type of *Pyrula* (*Melongena*) *bucephala*, Lamarck, while the last-named species and *Pyrula* (*Melongena*) *pugilina* show no differences from the living species of the same name.

PYRULA PUGILINA, Born., spec., Pl. XXI, figs. 2, 2*a*.

1847. *Pyrula pugilina*, Reeve, Monograph of the genus *Pyrula*, pl. I, figs. 1, 1a.

MEASUREMENTS.

Height . 75 mm. (approximately).
Width . 47·5 „

The shell is of fairly large size, pyriform in shape and consists of an elevated turreted spire and a large accuminate body whorl.

Embryonic whorls not observed.

There are only three spire whorls preserved, but it is unquestionable that there must have been at least five or six; the whorls are angular and rather high, separated by a deep undulating suture; the anterior part of the surface is almost vertical, the posterior smaller one deeply canaliculated by a strong furrow, which running close to the suture sets off a sort of pseudo-keel. The ornamentation consists of strong, but short spines, lining the ambitus.

The body whorl is high and large, anteriorly accuminated; the posterior part is set off by a row of strong but rather irregularly distributed spines, and deeply canaliculated by a revolving furrow. There are numerous striæ of growth, but no other ornamentation has been preserved.

Aperture not observed.

Geological occurrence.—

Zone of *Cytherea erycina*, Prome.

Remarks.—The only specimen which has come under examination is rather badly preserved being apparently considerably rolled before interment; in addition to the rolling a colony of young *Ostraeæ* has entirely covered the aperture and the last part of the body whorl, but notwithstanding these drawbacks it is easy to see that the specimen differs from *Pyrula bucephala* and *Pyrula pseudobucephala* by the absence of a second row of spines on the anterior part of the body whorl. Another distinctive feature is the deep furrow on the posterior part of the whorls, which sets off a sort of keel along the suture.

It seems not doubtful that the specimen under examination is identical with *Pyrula pugilina*, Born., spec., inhabiting the Eastern Seas. Shape and ornamentation, but particularly the canaliculated posterior part of the whorls agree perfectly with this species, as I have convinced myself by comparison with a specimen from the Indian Ocean. Under the name of *Pyrula ponderosa* K. Martin[1] distinguishes a species which seems to me identical with *Pyrula pugilina*, because I doubt whether the differences stated would be sufficient for a specific separation. Professor Martin states that the fossil species is much thicker and ponderous, that the furrow on the posterior part of the whorls is much deeper, and that the regular disappearance of the spines on some part of the whorls, form differences from the living species, which in that author's opinion could not be disregarded. This is of course a matter of opinion, but it may be questioned whether these differences can always be observed, particularly when the specimens are not absolutely well preserved. There is no doubt, and the examination of living species, as well as the study of Reeve's figures, has confirmed this view that the character of the peripheral spines, *viz.*, those lining the ambitus, is rather erratic; in some specimens they have almost entirely disappeared on the later whorls and are only visible on the earlier ones (*vide* Reeve's fig. 1*a*), while on others they disappear on the penultimate and reappear on the body whorl; in the fossil specimen here described, they are absent only on a small part of the body whorl, but reappear again later

[1] Die Fossilien von Java, page 93, Pl. XIV, figs. 208 22e, 88a.

on, the first spine being rather weak, while the others rapidly increase in size and thickness.

It may further be questioned whether *Pyrula madjalengkensis*, Mart., does not represent the smooth variety of *Pyrula pugilina*. Martin himself dwells on the strong similarity of this species with *Pyrula pugilina*, but he thinks that the strange accumination of the anterior part, as well as the different ornamentation of the earlier whorls, are sufficient for a specific separation.

PYRULA BUCEPHALA, Lamarck, Pl. XXI, figs. 3, 3*a*, 4, 4*a*.

1847. *Pyrula bucephala*, Reeve, Monograph of the Genus *Pyrula*, pl. VII, fig. 24.
1895. „ „ Martin, Fossilien von Java, p. 91, pl. XIV, figs. 206 and 207.

Unfortunately all the specimens which have come under examination are so ill-preserved that no accurate measurements could be made, but the shell must have attained a considerable size as one of the specimens measures not less than 68·5 mm. in length.

The shell was apparently pyriform in shape, and composed of a rather low turreted spire and a very large, conical body whorl.

Embryonic whorls not observed.

The spire consists of about four angular whorls separated by a deep undulating suture which increase slowly in height. The surface of the whorls is slightly concave and covered with numerous, somewhat irregular, fine revolving keels; the ambitus of the whorls is set with a row of strong and thick spines which are not quite completely hidden beneath the succeeding whorl.

The body whorl is very large and high, conical in shape and anteriorly strongly attenuated. There are two rows of strong spines; one close towards the posterior, and one close to the anterior end; the surface slopes gently from the posterior row towards the suture and more steeply in anterior direction. The anterior part bears a few revolving keels, otherwise the surface seems smooth, except for numerous striæ of growth which particularly appear on the posterior part.

Aperture not observed.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.

Remarks.—It is most unfortunate that all the specimens I have under examination are so badly preserved, because it seems that this species is liable to a great variation with regard to the shape of the shell; if I take fig. 3 as the type then the specimen fig. 4 which unquestionably belongs to the same species differs by a much higher spire and by a smaller number of spines, there being only six to one volution. It further appears from this specimen that the peripheral spines on the earlier spire whorls were developed in the shape of thick longitudinal ribs, which with increasing age gradually moved towards the ambitus.

It is unquestionable that the specimens under examination are identical with *Pyrula bucephala*, Lamk., which occurs, as Martin states, in the Indian Ocean.

Closely related to *Pyrula bucephala* is *Pyrula gigas*, K. Martin, which is, however, distinguished by a number of characters, of which the concave revolving band on the spire whorls seems to be one of the easiest features to recognise.

The specific difference of *Pyrula pseudobucephala* seems to be less certain, and it was only with hesitation that I separated this species from *Pyrula bucephala*, but there seems to exist certain constant features in both specimens of *Pyrula pseudobucephala* which rendered a specific separation advisable unless a very large margin of variation was allowed. These different features are the following: the shell appears to be more elongated in *Pyrula pseudobucephala* than in *Pyrula bucephala*, the spire is more elevated and the whorls are higher in the former than in the latter species; the most important differences consist, however, in the longitudinal section of the body whorl; in *Pyrula bucephala* this section forms a sharp angle with a short posterior and long anterior side; in *Pyrula pseudobucephala* this section forms a curve gently sloping in posterior and interior direction. It further appears as if the posterior row of spines was less strongly developed in *Pyrula pseudobucephala* than in *Pyrula bucephala*.

PYRULA PSEUDOBUCEPHALA, spec. nov., Pl. XXI, figs. 5, 6, 6*a*.

Unfortunately the two specimens which have come under examination are very badly preserved, but they still exhibit a sufficient amount of characters to allow of a satisfactory description.

The shell must have attained rather a large size, because one of the specimens measures not less than 107 mm. in length. The shape was apparently elongated, pyriform, and the shell was composed of a high, elevated spire and a large conical body whorl.

The number of spire whorls is not known, there being not more than four preserved; the whorls are angular, rather high and their surface is steeply inclined towards the undulating suture. The earlier whorls were set with about eight to nine thick, but short longitudinal ribs which gradually move towards the ambitus leaving the posterior part of the surface free. It is questionable whether besides the numerous striæ of growth there existed also a revolving ornamentation.

The body whorl is very high, strongly accuminate in anterior direction and set with two rows of strong spines; the posterior row appears to be the weaker of the two, and composed of spines greatly varying in strength. The longitudinal section of the body whorl is rather a flat curve, having its apex at the posterior row of spines and sloping a little steeper in posterior than in anterior direction. A number of flat revolving keels separated by linear interstices are seen in front of the anterior row of spines.

Aperture not observed.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, SinSu.

Remarks.—It was with the greatest disinclination that I separated this species from *Pyrula bucephala*, particularly as I thought that the state of preservation was not sufficient as to allow of a specific distinction. In comparing, however, the two specimens I examined with *Pyrula bucephala*, I found that they both had a number of features in common by which they differed from that species. I would have, therefore, been obliged to allow for a great variation in *Pyrula bucephala* or to distinguish the specimen under examination by a new name. I preferred the latter course; *Pyrula pseudobucephala* differs therefore from *Pyrula bucephala* by a more elongate shape, a more elevated spire composed of higher whorls, but particularly by the longitudinal section of the body whorl which is represented by a curve instead of a sharp angle as in *Pyrula bucephala*.

Family: *MURICIDÆ*, Tryon.

Genus: MUREX, Linné.

Only two species have come under examination, the generic position of one of which *Murex* (?) *tchihatcheffi*, d'Archiac and Haime, seems even very doubtful. Both species are so widely different in their specific characters that a synoptical table is superfluous.

No living relative of either *Murex arrakanensis* or *Murex* (?) *tchihatcheffi* could be discovered, and it seems almost certain that both represent indigenous types which are extinct among the present fauna of the Indian Ocean.

MUREX ARRAKANENSIS, Noetling, Pl. XXI, fig. 7, *a-e*.

1895. *Murex arrakanensis*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 36, pl. VIII, figs. 6, 6a, 6b.

MEASUREMENTS.

Height	21·0 mm.
Width	18·0 „
Apical angle	78°

The shell is of small size, pyriform in shape and consists of a short but elevated spire and a high ventricose body whorl.

Embryonic whorls not observed.

The spire consists of three or four rounded whorls, separated by a deep undulating suture, which increase rather quickly in height. The ornamentation consists of short but strong longitudinal ribs of which there seem to be three to one volution which are separated by three varices in such a way, that one rib appears in the interval between two varices; the whole surface of the whorls was apparently covered with fine revolving lines which are, however, almost worn away on the specimen under examination.

The body whorl is large and high, occupying about three-fourths of the total height; its posterior end is ventricose, anteriorly it is contracted, ending in a short truncated canal. The horizontal section is distinctly triangular on account

of the three varices, and the intermediate ribs have almost entirely disappeared. The last varix is the strongest and set with three spines, the posterior one of which is considerably stronger than the two others. On the penultimate varix these spines are just slightly indicated, while hardly any trace of them is visible on the preceding one. The whole surface is covered with numerous rounded revolving keels of varying strength separated by linear interstices. Two of these keels which run at about the middle of the height are perceptibly stronger than the others, and they appear on the varices as the two anterior spines.

The aperture is moderately large, posteriorly broad, rounded, accuminate in anterior direction. Outer lip very thick, sharp; inner lip callous, anteriorly well set off from the columella; anterior canal short, partly covered by the union of inner and outer lip.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.

Remarks.—Murex batavianus,[1] K. Martin, seems to be related to this species, though it apparently differs by a much richer ornamentation, stronger spines and a larger canal.

I failed to discover any living or fossil relative; so it seems almost certain that ***Murex arrakanensis*** represents an extinct type.

MUREX (?) TCHIHATCHEFFI, d'Archiac and Haime, Pl. XXI, figs. 8, 8*a*, 9, 9*a*.

1853. *Murex tchihatcheffi*, d'Archiac and Haime, Des. Anim foss. du groupe Num. de l'Inde, p. 31, pl. XXIX, fig. 25.

1895 „ „ Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 36, pl. VIII, fig. 5.

MEASUREMENTS.

Height . .	21 mm.
Width . .	13 „
Apical angle .	54°

The shell is of small size, short, ovate in shape, composed of a rather high shouldered spire and a short body whorl.

Embryonic whorls not observed.

There are only three spire whorls preserved, but there must have been at least five. The whorls are angular, deeply canaliculate at the posterior end, sloping vertically in anterior direction, thus producing the characteristic shape of the spire; the whorls increase rather quickly in height and are separated by a sharp suture. The ornamentation consists of strong longitudinal ribs of which there may be about nine to one volution separated by broad concave interstices; the ribs are somewhat club-shaped, being much thicker at the posterior than at the anterior end.

The body whorl is short, occupying apparently less than half the total height, ventricose and anteriorly contracted; the ornamentation is the same as on the spire whorls, only that the ribs become longer; a few indistinct revolving lines visible on the anterior end.

Aperture not observed; anterior canal apparently short.

Geological occurrence.—

Zone of *Paracyathus caeruleus*, Yenangyat.

Remarks.—The generic position of this genus is somewhat doubtful, considering that no features are expressed which would stamp it unquestionably as belonging to the genus *Murex*, but as no other specimens have come under examination in addition to the one described in my previous memoir, I have no valid reasons on which to change the generic name.

The characters as above described agree very well with d'Archiac's *Murex tchihatcheffi*, and the probability that the species here described is identical with that one is very great,[1] though to make it a certainty a comparison with Messrs. d'Archiac and Haime's type would be necessary.

Family: *VOLUTIDÆ*, Gray.

Genus: MARGINELLA, Lamarck.

MARGINELLA (GLABELLA) SCRIPTA, Reeve, Pl. XXI, fig. 10, *a-c*.

MEASUREMENTS.

Height	9 mm.
Width	5·5 „
Apical angle	not measured.

The shell is of small size, oval in shape, composed of a low spire and a large inflated body whorl.

The spire whorls, of which there may be three or four, are low and increase slowly in height; they are ill-observable, by being apparently covered with a fine coating of enamel.

The body whorl is large, ventricose, anteriorly truncated, occupying about four-fifths of the total height, has a perfectly smooth surface.

Aperture elongate but rather narrow, outer lip thin, rounded and well set off from the other part of the surface. The columella bears five equidistant, strong oblique plaits, the most anterior of which lines the anterior canal. Anterior canal short but broad, posterior canal slit-like.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Remarks.—The species bears a great similarity to *Marginella dijki*, K. Martin, with which it appears to agree perfectly in regard to the shape; the only difference between the two species concerns the strength of the collumellar plaits; counting in antero-posterior direction, in *Marginella* (*Glabella*) *scripta* the plaits are all of the same strength except No. 4, which is shorter than any of the others. In *Marginella dijki* on the other hand the plaits increase regularly in size in antero-

[1] Not *javanus* as erroneously printed in my previous Memoir.

posterior direction, and none of them seems to attain the size as observed in *Marginella* (*Glabella*) *scripta*.

Having compared this species with the living *Marginella* (*Glabella*) *scripta* I fail to discover any differences, the shape and the number of plaits being exactly the same; unfortunately I am unable to say whether the outer lip was crenulated within, as in the living species, or smooth, because, except a very small part at the posterior end insufficient to decide the question, the whole of the outer lip is broken off.

Genus: VOLVARIA, Lamarck.

VOLVARIA BIRMANICA, Noetling, Pl. XXI, fig. 11, *a-c*.

1895. *Volvaria birmanica*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 37, pl. VIII, figs. 7, 7*a*, 7*b*, 7*c*.

MEASUREMENTS.

Height . . .	13·6 mm.
Width . . .	5·0 „
Apical angle . .	Not measured.

The shell is of small size, cylindrical in shape, composed of a very short, perfectly concealed spire and a long body whorl. As the spire is perfectly hidden by the body whorl, nothing can be said about the spire whorls.

The body whorl is elongate, subcylindrical in shape, posteriorly accuminate, anteriorly truncated. The ornamentation consists of numerous sharply engraved revolving furrows, which are separated by flat interstices of about twice the breadth of the separating furrows; fine longitudinal, equidistant striæ, which are only visible in the furrows, produce a very delicate lattice work. A few coarse striæ of growth visible at irregular intervals; aperture very long and narrow; outer lip thick but sharp; inner lip slightly callous towards the posterior end; four strong columellar plaits; anterior canal short, broad.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.

Remarks.—No other specimens have been found and the specimen here described is the same as mentioned in my previous memoir. I formerly mentioned that *Volvaria birmanica* might perhaps be compared with *Volvaria multicingulata*, Sandberger, though I stated at once that both species are different. I think that *Volvaria acutiuscula*, Sow., from the Paris Eocene is a still nearer relative, though only an actual comparison could settle the question of relationship.

As I failed to discover any living relatives, *Volvaria birmanica* apparently represents a type which is extinct among the present fauna of the Indian Ocean, but which most probably has its relatives among the fauna of the Eocene of Paris.

Genus: VOLUTA, Linné.

Only two species have come under examination which can be distinguished as follows:—

A. Body whorl low, set with a row of strong spines on its last part.

1. *Voluta ringens*, spec. nov.

B. Body whorl high, set with short spines all over its length.

2. *Voluta dentata*, Sowerby.

I have not been able to discover any living relatives of both species and it seems certain that both represent types which are at present extinct among the fauna of the Indian Ocean. No fossil relative of *Voluta ringens* could be traced, but there is a great probability that *Voluta dentata* has a very near relative in *Voluta bicorona*, Lamarck, of the Paris Eocene.

VOLUTA RINGENS, spec. nov., Pl. XXI, figs. 12, *a-b*, 13.

1895. *Strombus nodosus*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, Vol. XXVII, p. 24, pl. V, fig. 11.

MEASUREMENTS.

	I	II
Height . .	28 mm. (approx.)	20 mm. (approx.).
Width . .	20 „	13 „
Apical angle .	?	75°

The shell is of small size, pyriform, and composed of a low but elevated spire and a high anteriorly accuminate body whorl.

Embryonic whorls not observed.

The spire consists of about 4 to 5 slightly rounded, almost flat whorls, which increase rather quickly in height and are separated by a deep suture. The earlier whorls seem to be perfectly smooth; gradually some faint longitudinal ribs begin to appear, which slowly increasing in strength again die out on the penultimate whorl; these ribs are rounded, rather thick and separated by broad interstices. Soon after the first ribs have appeared, the surface of the whorls is covered with numerous fine revolving lines, varying somewhat in strength.

The body whorl is very large, occupying more than two-thirds of the whole height, ventricose at its posterior, accuminate at its anterior end. On its older part the longitudinal ribs are still visible, though they are very faint and soon disappear entirely, and their place is occupied by short spines, which though not appearing earlier than the last half of the whorl, quickly attain considerable strength; these spines mark a sort of indistinct keel, behind which the surface slopes gently towards the suture, becoming slightly concave at the same time. The whole surface is covered with fine, rounded, revolving lines, varying, however, somewhat in strength; these are separated by interstices in which now and then a finer line appears.

Aperture not observed.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.

Remarks.—In my previous memoir I considered this species as identical with *Strombus nodosus*, Sow., though I confess on the strength of the very ill-preserved specimen as represented by fig. 11. Having since obtained a better-preserved specimen the former determination must be considered as erroneous. As this specimen, though not particularly well preserved either, exhibits no trace of an expanding outer lip, it cannot belong to the genus *Strombus*, and the probability that it represents a *Voluta* is great, though the characters of the aperture have not been observed.

Voluta ringens differs from *Voluta dentata* by the comparatively shorter body whorl, but particularly by the strong spines appearing on the latter half of the body whorl.

There exists no doubt a sort of general likeness between *Voluta ringens* and *Strombus nodosus*, Sow., as depicted by Messrs. d'Archiac and Haime, but I refrain from further comments until I have had an opportunity of examining *Strombus nodosus* as understood by these authors.

Voluta ringens has no living relative, nor could I discover any fossil species to which it might be compared; it probably represents an ancient type which is now extinct.

VOLUTA DENTATA, J. de Carle Sowerby, Pl. XXI, figs. 14, *a-d*, 15, *a-b*; Pl. XXII, figs. 1, 1*a*, 2, 2*a*, 3, 3*a*.

1840. *Voluta dentata*, J. de Carle Sowerby, Transact. Geolog. Soc. of London, 2nd ser., Vol. V, pl. XXVI, fig. 26.

1853. " " d'Archiac and Haime, Descr. des Anim. foss. du groupe nummul. de l'Inde, p. 324, pl. XXXII, figs. 2, 2*a*; pl. XXXIII, fig. 11.

1895. " " Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 37, figs. 8, 8*a*, 9, 10.

MEASUREMENTS.

Height . . .	37 mm.
Width . . .	19 ,, (approx.).
Apical angle . .	80°

The shell is of small size, pyriform in shape and composed of a short elevated spire and a high anteriorly attenuated body whorl.

Embryonic whorls not observed.

The spire is composed of about five whorls which are rounded at first, but afterwards become angular and slightly concave at the posterior part. The whorls are low, increasing only slowly in height and are separated by a sharp suture. The ornamentation consists of short spines representing the posterior end of longitudinal

ribs, following at equal intervals and lining an indistinct revolving keel which separates the posterior, slightly concave portion of the surface from the anterior one.

The body whorl is very high occupying about three-fourths of the total height; the posterior end is broad and ventricose, the anterior end accuminate. The ornamentation is the same as on the spire whorls, only that it is distinctly seen that the short spines represent the posterior end of longitudinal, rather sharp but short ribs, which become perfectly effaced on the anterior half of the surface and are sometimes even still shorter, particularly towards the aperture. The whole surface, except the concave posterior part, is covered with sharply engraved revolving lines separated by flat interstices of varying breadth. Towards the anterior end the lines turn into narrow, but deep furrows and the interstices into raised keels of varying breadth.

The aperture is long and narrow; the outer lip rather thick, rounded and somewhat reflected. The columella is set with five strong spiral plaits, which are, however, only visible when a part of the last whorl is removed as rhey apparently do not extend right up to the end of the aperture. Anterior canal short but broad.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.
Zone of *Paracyathus caeruleus*, Yenangyat.

Remarks.—There seems to be no doubt that the specimens here described are identical with *Voluta dentata*, Sowerby, the shape and ornamentation agreeing perfectly.

Voluta dentata varies a great deal during the different stages of growth, and young ones having the whole surface of the body whorl covered with longitudinal ribs, which are intersected by sharply engraved revolving lines, differ considerably from full grown ones, in which the longitudinal ribs are so much reduced that only short spines remain.

For this reason I considered in my previous memoir *Voluta cythara*, d'Archiac and Haime, as identical with *Voluta dentata*, Sow., but having again examined the figures given by those authors my former view seems not quite founded. It appears to me rather doubtful whether fig. 4 and fig. 5 of *Voluta cythara* really represent the same species, fig. 4 having apparently a much higher spire and a smaller number of ribs and spines; whether this specimen represents really the same species as that of fig. 5 will perhaps never be decided, because fig. 4 is apparently a cast in a poor state of preservation. For the same reason it will be impossible to say whether it is identical or not with *Voluta dentata* which appears unquestionably different from *Voluta cythara* as represented by fig. 5.

I have not been able to discover any living relative among the fauna of the Indian Ocean, and it appears certain that *Voluta dentata* represents an extinct type which has probably some relationship with *Voluta dentata*, Desh., from the Paris Eocene.

Family: *OLIVIDÆ*, d'Orbigny.

Genus: OLIVA, Brugière.

OLIVA (STREPHONA) RUFULA, Duclos, Pl. XXII, figs. 4, *a-c*, 5, 5*a*.

1868. *Oliva rufula*, Duclos, Reeve, Monograph of the genus *Oliva*, pl. XX, fig. 60.
1895. *Oliva djocdjocartæ*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 38, pl. IX, figs. 1, 1*a*, 1*b*, 1*c*.
1897. *Oliva rufula*, var. *djocdjocartæ*, K. Martin, Fossilien von Java, p. 58.

MEASUREMENTS.

Height .	. 22 mm.
Width .	. 8 „
Apical angle .	52°

The shell is of small size, sub-cylindrical in shape and composed of a short but elevated spire and a very high body whorl.

Embryonic whorls not observed.

The spire which occupies less than one-fourth of the total height is composed of about four to five flat whorls, which are separated by a deeply incised suture. The whorls increase rather quickly in height and are perfectly smooth, apparently covered with a shining epidermis.

The body whorl is very high and occupies at least three-fourths of the total height; it is sub-cylindrical in shape, anteriorly truncated, slightly accuminate in posterior direction. The surface is smooth except for numerous longitudinal striæ of growth, which are not visible at the anterior end, where they are covered by the enamelled spiral band.

Aperture rather large and wide, elongate; broad at the anterior, accuminate at the posterior end; outer lip sharp and thick; columella set with five strong spiral plaits, the last of which meets the spiral band at a very sharp angle; enamelled spiral band rather broad, anterior canal short, but broad.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Paracyathus caeruleus*, Yenangyat.
Zone of *Cancellaria martiniana*, Minbu.
Zone of *Arca theobaldi*, Kama.
Zone of *Parallelipipedum prototortuosum*, Kama.
Zone of *Aricia humerosa*, Thayetmyo.

Remarks.—K. Martin has since recognised that *Oliva djocdjocartæ* cannot be considered anything else but a variety of *Oliva rufula*, Duclos, a view in which I perfectly agree with him. As the specimens examined agree so closely with that species I preferred to consider them as identical, not as varieties only.

Genus: ANCILLARIA, Lamarck.

ANCILLARIA CF. VERNEDEI, Sowerby, Pl. XXII, fig. 6.

1864. *Ancillaria vernedei*, Sowerby, Reeve, Monograph of the Genus *Ancillaria*, Pl. I, fig. 1.
1895. „ „ K. Martin, Fossilien von Java, p. 67, pl. IX, fig. 152.

MEASUREMENTS.

Length .	38 mm.
Width .	14·5 „
Apical angle	35°

The few specimens which have come under examination are in such a poor state of preservation that their specific features could not be made out in a satisfactory manner. The shell appears to be of medium size, ovately elongated in shape, consisting of a high accuminate spire and a large angular body whorl.

The spire consists of about four to five angular whorls which rapidly increase in height; the suture is ill-seen as it is covered with a callous deposit, which also extends over the whorls. The body whorl is large, high, somewhat angular by an indistinct keel from which the posterior part of the surface slopes generally towards the suture, while the anterior part is almost vertical. There is no ornamentation except numerous striæ of growth.

Aperture not observed.

Geological occurrence.—

Zone of *Pholas orientalis*, Thayetmyo.
Zone of *Aricia humerosa*, Thayetmyo.
Zone of *Cytherea erycina*, Prome.

Remarks.—The specimens are too ill-preserved to allow for a more detailed comparison; their general shape is the same as *Ancillaria vernedei*, but as the character of the aperture could not be observed, the determination may be somewhat doubtful.

4TH SECTION: TOXIGLOSSA, Troschel.

Family: *CANCELLARIIDÆ*, Adams.

Genus: CANCELLARIA, Lamarck.

On the following pages five species have been described which, with regard to shape and ornamentation, are so widely different from each other, that the only feature which they have had in common is a number of columellar plaits ranging from one to three.

Under these circumstances, it appears somewhat doubtful whether the generic position of at least two, *Cancellaria neavolutella* and *Cancellaria martiniana*, is correct. The aperture of the former species has not been observed at all, its generic position has only been determined from its great similarity with *Cancellaria volutella*, Lmk. Under ordinary circumstances, the general appearance of the shell would have led to its classification among the genus *Triton*.

A similar, and perhaps still greater doubt, prevails with regard to *Cancellaria martiniana*, the general appearance of this species is that of a *Ranella*, yet it cannot belong to that genus owing to the irregularity of the varices; this feature would speak more in favour of *Triton*, yet the difference of shape, and the columellar plait which, though weak, is distinctly visible, prove that it cannot be included among that genus. I hesitated for a long time whether I should not describe it under a new generic name, yet there were no particularly distinctive features to justify this, and as most of its characters agreed with those of *Cancellaria*, I included it among that genus.

No doubt can exist with regard to the generic position of the other three species, the characters of which are certainly those of *Cancellaria*.

The five species can be distinguished as follows :—

A. Shell elongate.
 1. *Cancellaria neavolutella*, spec. nov.

B. Shell short.
 (*a*) Surface without longitudinal ribs.
  2. *Cancellaria inornata*, spec. nov.
 (*b*) Surface with longitudinal ribs.
  (*aa*) With revolving keels.
   α Aperture large and wide.
    3. *Cancellaria pseudocancellata*, spec. nov.
   β Aperture small, restricted.
    4. *Cancellaria davidsoni*, d'Archiac and Haime.
  (*bb*) Without revolving keels.
   5. *Cancellaria martiniana*, spec. nov.

The relationship of these five species is as varied as their specific feature. None has any living relative among the fauna of the Indian Ocean, and all of them must be considered as extinct types, yet one species, *Cancellaria pseudocancellata*, is so closely related to *Cancellaria cancellata*, Lmk., from the Mediterranean, that it is almost impossible to distinguish it from this species.

Of the remaining four species *Cancellaria neavolutella* is very closely related to *Cancellaria volutella* of the Paris Eocene, while no fossil relatives could be discovered of *Cancellaria inornata*, *Cancellaria davidsoni*, and *Cancellaria martiniana;* though not so certain with regard to the former two, it is almost absolutely certain that *Cancellaria martiniana* represents an indigenous type, the nearest relatives of which must have existed in the older Indian Tertiaries.

CANCELLARIA NEAVOLUTELLA, spec. nov., Pl. XXII, figs. 7, *a-b*, 8, 8*a*.

MEASUREMENTS.

Height	. 12·5	mm. (incomplete).
Width	. 6·6	„
Apical angle	35°	

The shell is rather delicate, of small size only, elongately ovate, composed of an elevated spire and a short body whorl.

Embryonic whorls not observed.

The spire is composed of at least seven rounded whorls, slowly increasing in height and separated by a deep suture. The earlier whorls were probably smooth, and destitute of ornamentation; on the later whorls the ornamentation consists of fine longitudinal equidistant ribs which gradually increase in strength; ribs and interstices are crossed by numerous very regular and sharply engraved revolving lines which are separated by rather broad flat bands. The varices are rather low and there are about three to one volution. The body whorl is comparatively short inflated; the ornamentation is the same as on the spire whorls, only that the flat bands between the revolving lines are raised into low flat keels towards its anterior end, while the longitudinal ribs die out.

Aperture and anterior canal not observed.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Remarks.—This species bears some similarity to *Triton ligatum* as regards the shape of the shell, having the same elongated shape, the high spire and the seemingly short body whorl. It is, however, easily distinguished by its different ornamentation; in *Triton ligatum* the longitudinal ribs are crossed by revolving keels, in *Cancellaria neavolutella* they are crossed by sharply engraved, very regular lines.

Though the generic position of this species is not quite beyond any doubt, the spiral plaits of the columella not having been observed, the shape of the shell and the character of ornamentation agree so well with *Cancellaria volutella*, Lmk., from the Eocene of Paris, that it seems difficult to discover any difference. As, however, the characters of the aperture are not known, I thought it better to distinguish it under a new name.

Cancellaria neavolutella has no living relatives in the fauna of the Indian Ocean, and it represents a type which has since died out.

CANCELLARIA INORNATA, spec. nov., Pl. XXII, fig. 9, *a-e*.

MEASUREMENTS.

Height	.	9·5 mm.
Width	.	6·8 „
Apical angle		86°

The shell is of small size, rather globose, ovate in shape and composed of a low though elevated spire and a large body whorl.

Embryonic whorls not observed.

The spire consists of 4 to 5 slightly inflated whorls which gradually increase in height and are separated by a deep suture. It appears that the earlier whorls were smooth, but the later whorls are covered with about 10 to 12 fine, slightly plicose revolving keels of equal strength, separated by fine, linear interstices.

The body whorl is rather large, strongly inflated and exhibits the same ornamentation as observed on the spire whorls, only that the keels become a little

stronger, the interstices a little broader, while here and there a fine filiform keel is interpolated between two stronger ones; besides the revolving keels there are numerous, sometimes coarse, sometimes finer striæ of growth, which assume the character of longitudinal ribs.

Aperture rather large, elongately oval, but unfortunately damaged; outer lip not observed, but probably thick, internally set with numerous sharp revolving plications. Columella set with three oblique spiral plaits, the most posterior of which is the strongest.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Remarks.—No similar species has hitherto been described either from Western India or Java and Sumatra.

CANCELLARIA PSEUDOCANCELLATA, spec. nov., Pl. XXII, fig. 10, *a-c*.

1895. *Cancellaria cancellata*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 39, pl. IX, figs. 2, 2*b*.

MEASUREMENTS.

Height	. 13·5 mm.
Width	. 10·5 „
Apical angle	65·°

The shell is of small size, ovate globose in shape and composed of a low, but elevated spire and a large ventricose body whorl.

Embryonic whorls not observed.

Only two spire whorls are preserved which are strongly inflated, separated by a deep suture and rather quickly increase in height. The ornamentation consists of about 12 to 13 strong rounded, longitudinal ribs separated by broad concave interstices; the ribs are slightly oblique and accuminate at both ends; ribs and interstices are covered with numerous, closely set, revolving keels separated by linear interstices; the keels are of different strength and usually a finer one occurs between two stronger ones. With a strong magnifying lens a very fine longitudinal plication is seen in the interstices of the revolving ribs.

The body whorl is large, inflated, somewhat attenuated in front; the ornamentation is the same as on the spire whorls, strong longitudinal ribs, crossed by fine revolving keels; both become, however, stronger and it can be distinctly seen that the decussate ornamentation of the interstices is produced by very fine, longitudinal striæ which are worn off on the ribs and only appear in the interstices.

The aperture is rather large, oval in shape, the outer lip is sharp, denticulate within, inner lip thin, partly covering the columella, columella short, set with a few spiral folds which are, however, ill seen.

Geological occurrence.—

Zone of *Paracyathus caeruleus*, Yenangyat.

Remarks.—This species is easily distinguished from *Cancellaria inornata* by the strong longitudinal ribs, crossed by well-marked revolving keels; on the other

hand, the distinction from *Cancellaria davidsoni* seems somewhat difficult. On closer examination it will, however, be seen that it is distinguished by a shorter spire, a finer ornamentation, but particularly by a wide and open aperture which is not restricted by an inflated outer lip.

In my previous memoir I identified this species with *Cancellaria cancellata*, Lmk., but having since compared several specimens of that species, I think this view must be modified. *Cancellaria cancellata* has unquestionably a higher spire and the number of longitudinal ribs as well as that of the revolving chords is less numerous than in *Cancellaria pseudocancellata*. On the other hand, a great similarity between the two species cannot be denied, and as *Cancellaria cancellata* does not occur among the fauna of the Indian Ocean, *Cancellaria pseudocancellata* represents the only species hitherto found which bears any relationship to a species living outside the Indian province and occurring also in a fossil state in the Miocene of Vienna.

CANCELLARIA DAVIDSONI, d'Archiac and Haime, Pl. XIX, figs. 23, *a-b*; Pl. XX, fig. 1, *a-c*.

1853. *Triton davidsoni*, d'Archiac and Haime, Desc. des. Anim. foss. du Groupe num. de l'Inde, p. 312, pl. XXX, figs. 3*a*, 6.

1896. „ „ Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1896, Vol. XXVII, p. 29, pl. VI, figs. 6, 6*a*.

MEASUREMENTS.

Height .	more than 16 mm.
Width . .	10·5 „
Apical angle .	59°

The shell is of small size, ovate in shape and composed of more than four whorls forming a turreted spire and a short body whorl.

Embryonic whorls not observed.

Only three spire whorls are preserved, though it is unquestionable that there have been more; the whorls are low rather inflated, separated by a deep undulating suture and increase slowly in height. The ornamentation consists of strong, rounded, slightly oblique longitudinal ribs of which there may be 12 to one volution, separated by rather broad interstices. These ribs are crossed by a number of fine equidistant revolving keels, which when crossing the longitudinal ribs, are raised into low elongated knobs. In the interstices of the revolving keels there are several fine, revolving lines, which are, however, only visible in well preserved specimens. There are a few varices, about three to one volution, which, however, are hardly discernible from the ribs.

The body whorl is rather short, strongly inflated, anteriorly attenuated exhibiting the same ornamentation as the spire whorls, terminating in a thick inflated varix, largely restricting the aperture; aperture elongately oval, but rather small; outer lip sharply raised, inner lip thin, covering the columella which bears three plaits, the central one of which is the strongest; no posterior canal, anterior canal short, recurved and ascending.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.

Zone of *Paracyathus caeruleus*, Yenangyat.

Remarks.—The species here described represents one of those which unless exceedingly well preserved, thus allowing all their distinguishing features to be seen, are open to any sort of interpretation; the shape is *Ranella*-like, while the irregularly distributed varices would more speak for *Triton*; the ornamentation is exactly like that of the living *Nassaria recurva* from the Indian Ocean.

In my previous memoir I considered this species to belong to the genus *Triton*, but having since discovered the columellar plaits, it is unquestionable that this view must be wrong; shape, ornamentation and columellar plaits prove therefore that it must belong to the genus *Cancellaria*.

Cancellaria davidsoni closely resembles *Cancellaria pseudocancellata*, from which it is however distinguished by a higher spire, a coarser revolving ornamentation, but particularly by the inflated outer lip which greatly reduces the width of the aperture. In my previous memoir I identified this species with *Triton javanus*, K. Martin, a view which was fully justified, considering the great similarity of the shape and ornamentation of both species.

I further drew attention to the similarity with *Tritonium samaranganum*, K. Martin, which exhibits exactly the same ornamentation, particularly the compressed nodules on the longitudinal ribs. The view of a possible identity is particularly strengthened by the apparent existence of two columellar plaits, which are distinctly depicted in the right-hand figure of *Tritonium samaranganum*, and which are not mentioned in the description.

I could not discover any living relative of *Cancellaria davidsoni*, and the species probably represents a type which does no longer exist among the fauna of the Indian Ocean. On the other hand it seems as if *Cancellaria davidsoni* were a close relative of *Cancellaria evulsa*, Sow; the shape of the shell and the ornamentation are so similar that it seems difficult to discover any differences from the figure only, but it seems to me that the longitudinal ribs of *Cancellaria davidsoni* are stronger and less numerous, as in fact the whole ornamentation of this species appears coarser than that of *Cancellaria evulsa*.

CANCELLARIA MARTINIANA, spec, nov., Pl. XXII, figs. 11, *a-d*, 12, 12*a*, 13, *a-c*.

1895. *Nassa cautleyi*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, Vol. XXVII, p. 32, pl. VII, figs. 2, 3, 4, 4*a*.

MEASUREMENTS.

Height	.	more than 21 mm.
Width	.	14 „
Apical angle	.	63°

The shell is of small size only, bucciniform in shape, composed of 7 to 8 whorls forming a short, conical spire and a large inflated body whorl.

Embryonic whorls not well observed, apparently smooth and without any ornamentation.

The spire which occupies less than half of the total height is composed of about 6 flat whorls slowly increasing in height and separated by a sharp suture. The ornamentation consists of numerous, fairly strong longitudinal ribs which are slightly bent, fairly equidistant and separated by broad concave interstices; on the earlier spire whorls these ribs are crossed by a few, sharply raised revolving chords which on the later whorls become very weak; now and then, at irregular intervals, a low varix is visible.

The body whorl is large, occupying more than half of the total height of the shell, inflated, attenuated in anterior direction. The ornamentation is the same as on the spire whorls, only that the longitudinal ribs become stronger, but die out in anterior direction. The revolving lines are arranged in two groups, separated by a smooth central band; the posterior group, which runs next to the suture, is composed of about 7 or 8 lines which now take the shape of low and smooth chords, separated by linear interstices and corresponds unquestionably to those seen on the spire whorls, the anterior group is composed of 12 to 15 smooth rounded chords, increasing in strength from the centre in anterior direction; at the same time the interstices become broader, and filiform lines appear between two keels.

The aperture is moderately large, rounded posteriorly, attenuated in anterior direction. The outer lip is strongly callous, crenulated within; the inner lip thin, covering the columella which bears a single, generally not well visible spiral plait; there is a rudimentary posterior canal, which appears as a sort of shallow short notch of the outer lip; the anterior canal is short, narrow, but slightly expanded in front.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.

Zone of *Paracyathus caeruleus*, Yenangyat.

Remarks.—In my previous memoir I considered this species as belonging to the genus *Nassa*, but on closer examination I believe that this determination must be erroneous. *Nassa* does not exhibit varices like this species, but, on the other hand, one of the chief characteristics of *Nassa* is the extremely callous inner lip which in this species is certainly absent. Under these circumstances, the species under examination cannot be considered as belonging to the genus *Nassa* nor could *Buccinum* come in question either.

The above characters, a callous outer lip crenulated within and varices distributed irregularly over the spire whorls, but particularly the columellar plait, prove that the species here described must belong to another genus, and I think that I am not wrong in assuming its generic position among the genus *Cancellaria*.

I also believe I was wrong in identifying this species with *Buccinum cautleyi*, d'Arch. and Haime, though I am not quite so certain about this point. There is unquestionably a great similarity between *Cancellaria martiniana* and *Buccinum cautleyi*, d'Arch. and Haime, the ornamentation of the shell being apparently the same; even the peculiar arrangement of the revolving keels on the

body whorl is indicated in *Buccinum cautleyi*. On the other hand, this species appears to be more elongated, a character to which I would, however, not attribute too much value; of more importance is the entire absence of varices which are neither mentioned in the description nor shown in the figure. If this feature is not due to an oversight it would at once establish the generic difference of both species, but as I am not quite sure about this, it must be left to future researches to decide whether *Buccinum cautleyi* really differs by this character from *Cancellaria martiniana* or not. For the present I prefer to distinguish the specimens from Burma under a separate name.

That, under these circumstances, no relationship can exist with *Nassa siquijorensis*, Mart., as I believed in my previous memoir is obvious, this species being at once distinguished by the absence of varices.

No similar species has been described from either Java, Sumatra or Western India, and I have not been able to discover any fossil species to which *Cancellaria martiniana* might be compared. I could not further discover any living relative either among the fauna of the Indian Ocean or among the other species figured in Reeve's monograph. Unfortunately I have not been able to see Jousseaume's monograph of the genus *Cancellaria* quoted by Cossmann,[1] and cannot therefore state with certainty whether this species has any living relative or not. So far it seems that it represents a truly indigenous type which may probably have its predecessors in the Indian Eocene, but which is not represented among the fauna now inhabiting the Indian Ocean.

Genus: TEREBRA, Adamson.

On the following pages seven species have been described, two of which have, however, not been distinguished by specific names, though it is certain that they represent species which are different from the others. But as only fragments of these two species have come under examination, I thought it wiser to leave them unnamed in order not to prejudice future researches.

These six species represent the following three sub-genera :—*Terebrum*, Montfort, *Strioterebrum*, Sacco, *Subula*, Schumacher, and they can be easily distinguished as follows :—

A. Ornamentation of earlier spire whorls not different from those of the later ones.
- (*a*) Revolving chords present: *Strioterebrum*—
  - (*aa*) One broad keel at the posterior side of the whorls.
    1. *Strioterebrum protomyuros*, spec. nov.
  - (*bb*) One broad keel at the anterior side of the whorls.
    2. *Strioterebrum unicinctum*, spec. nov.
  - (*cc*) One broad keel at the anterior, and a narrow one at the posterior side of the whorls.
    3. *Strioterebrum bicinctum*, K. Martin.

[1] Catal. de Coq. Foss., Vol. IV, p. 220.

(*b*) Revolving keels absent : *Terebrum*—

(*aa*) Anterior portion of ribs straight, posterior portion short.

4. *Terebrum protoduplicatum*, spec. nov.

(*bb*) Anterior portion of ribs curved, posterior portion long.

5. *Terebrum smithi*, K. Martin.

(*cc*) Anterior and posterior portion of ribs barely separated.

6. *Terebrum*, spec.

B. Ornamentation of earlier spire whorls different from those of the later ones.

7. *Subula*, spec.

If we omit the two species which have not been specifically determined, though *Subula* spec. is most probably related to either the living *Subula dimidiata* or *Subula muscaria*, there remain five species about whose relationship some definite statements can be made. Two species, *Terebrum smithi* and *Strioterebrum bicinctum* are identical with species from the Miocene of Java; two species, *Strioterebrum protomyuros* and *Terebrum protoduplicatum*, are so closely related to the living *Strioterebrum myuros* and *Terebrum duplicatum*, that they are perhaps identical with these species, because they apparently do not represent a permanent juvenile stage. The first named is very probably also identical with a species occurring in Western India. The relationship of *Strioterebrum unicinctum* could not be traced and it probably represents an extinct type.

STRIOTEREBRUM PROTOMYUROS, spec. nov., Pl. XXII, figs. 14, 14*a*.

1840. *Terebra reticulata*, J. de Carle Sowerby, Transact. Geolog. Soc. of London, 2nd ser., Vol. V, 1840, pl. XXVI, fig. 3.

The fragments which have come under examination are very ill-preserved, but notwithstanding their poor state of preservation the characters could sufficiently be made out for determination.

The shell was of rather a large size, elongately turreted in shape, the apical angle being probably not more than 7°.

The whorls are rather high, flat and increase very slowly in height, and slightly overlap each other; the suture is sharply marked. The ornamentation consists of a broad, raised and flat posterior, revolving keel well separated by a deep furrow from the slightly concave anterior part of the surface; in front of the keel are a number of revolving lines, somewhat irregular in strength, which on the later whorls also cover the broad posterior keel which on the earlier whorls appears to be free of them. The revolving keels are crossed by longitudinal ribs, which are rather strong and slightly oblique on the posterior keel, while they are finer and broadly curved on the anterior part of the surface.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Remarks.—This species is easily distinguished from all the others by the single broad posterior keel having a number of filiform lines in its front.

Notwithstanding the poor state of preservation it seems very probable that the specimens under examination are identical with Sowerby's *Terebra reticulata ;* the

ornamentation is apparently the same; at least as can be judged from the meagre description and the poor figure, it must be as above described.

Under the name of *Terebra javana* K. Martin describes a species which is unquestionably closely related, if not identical, to *Terebra reticulata*, the author himself draws attention to this close relationship and remarks that the only difference consists in the revolving striæ being finer and closer set in *Terebra reticulata* than in *Terebra javana*; whether such a minute difference constitutes a specific distinction is a matter of opinion, because a certain variation in the strength of the ornamentation must be allowed. It is, however, certain that *Terebra reticulata* from Burma differs by the same feature from *Terebra javana* from Java.

Among the living species *Terebra myuros*, Lamk., is such a near relative that it is almost impossible to discover any differences, even though the specimens are as badly preserved as those under examination. *Terebra myuros* exhibits the same broad and flat keel on the posterior side of the whorls, and in front of it a slightly concave surface which is covered with four stronger and four weaker revolving chords, separated by rather broad interstices. These are crossed by numerous longitudinal ribs of about the same strength as the stronger keels, producing a neat decussate ornamentation; on the posterior keel the ribs are raised into short slightly oblique nodules which are, however, more marked on the earlier than on the later whorls.

The only difference which I can discover consists in a sharp and deep furrow, which divides the posterior keel into a narrow anterior and a broader posterior band.

The specimens of *Strioterebrum protomyuros* which I examined are unfortunately too ill-preserved to state with certainty whether there exists such a furrow or not; at some parts it seems as if there was the same furrow, while at others the keel appears undivided; I think, however, that this is only due to the preservation, and the weaker anterior division has been worn off, but not being certain in this regard I preferred to distinguish this species under a separate name which expresses, however, the close relationship with *Terebra myuros*.

Though the older name *Terebra reticulata*, Sow., would deserve priority, I consider myself justified for substituting a new one, because it is not beyond all doubt that *Terebrum protomyuros* is identical with *Terebra reticulata*, Sow., but if so, because *Terebra reticulata* would be identical with *Terebra myuros*, provided the existence of the furrow dividing the posterior keel can be proved.

STRIOTEREBRUM UNICINCTUM, spec. nov., Pl. XXII, figs. 16, 16*a*.

MEASUREMENTS.

Height . .	?
Width . .	?
Apical angle .	8°

Only a single fragment, measuring about 15 mm. in length, has come under examination, but it shows that the shell which was elongate, turreted in shape, and must have attained a considerable size.

The whorls, which increase very slowly in size, are slightly convex and separated by a very ill-defined suture. The ornamentation consists of a broad, rather thick anterior revolving keel, set with numerous slightly oblique, elongate tubercules following at regular intervals, and two strings of rounded beads, the central one of which is slightly larger than the posterior one and appears as a semi-detached part of the broad anterior keel; a deeply engraved furrow almost resembling the suture separates the posterior string from the central one.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Remarks.—Though very similar in shape and ornamentation to *Terebra bicincta*, it is easily distinguished by having only one, but broad keel, which is followed by two strings of beads; in *Terebra bicincta* there are two keels, separated by a slightly concave band, filled up with a few filiform keels.

Notwithstanding its great similarity with *Terebra bicincta*, there cannot be the slightest doubt that *Strioterebrum unicinctum* represents a different species which has, however, no relative either in the Tertiary of Java and Sumatra or Western India. Neither can I find a living species to which it might be compared, nor is there any fossil species which bears any resemblance. *Strioterebrum unicinctum* represents therefore a type which does no longer exist among the present fauna of the Indian Ocean.

STRIOTEREBRUM BICINCTUM, K. Martin, Pl. XXII, figs. 15, 15*a*.

1879-80. *Terebra bicincta*, K. Martin, Tertiärsch. auf Java, p. 33, pl. VI, fig. 13.

MEASUREMENTS.

Height	?
Width	?
Apical angle	8°

Only two fragmentary specimens, each measuring about 15 mm. in length, have come under examination, but they are sufficient to determine the specific characters.

The shell must have attained a considerable size, and is elongately turreted as is indicated by the small apical angle. It was apparently composed of a great number of whorls, which very slowly increase in height; the suture is ill-seen and the surface of the whorls are flush with each other.

The revolving ornamentation consists of a broad, well raised granulose anterior keel, and a similar but somewhat weaker posterior one; the broad intermediate band is filled up by three to four filiform, equidistant keels. These keels are intersected by fine longitudinal ribs, which follow each other at regular, rather broad intervals; on the point of intersection with the posterior and anterior keel, strong elongate nodules are raised, while on the finer intermediate keels only low nodules are produced.

Aperture not observed.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Remarks.—This species agrees so well, even with regard to the minute details of the ornamentation with Martin's *Terebra bicincta* from Java, that there can be no doubt as to its identity. It is very closely related to *Strioterebrum unicinctum*, but a careful examination shows that in *Strioterebrum unicinctum*, the ornamentation consists only of one broad anterior keel followed by two strings of beads.

Strioterebrum protomyuros is easily distinguished by having only one broad revolving keel at the posterior side of the whorls, but I admit that, if rolled, *Strioterebrum bicinctum* would be very difficult to distinguish from *Terebrum myuros*, because the position of the suture could only with difficulty be decided on. It might then appear as if two keels, separated by a deep furrow, existed at the posterior side of the whorls as in *Terebrum myuros*, and not one keel at the anterior and posterior side of the whorls, that is to say, that the separating furrow represents the suture as in *Strioterebrum bicinctum*.

TEREBRUM PROTODUPLICATUM, spec. nov., Pl. XXII, figs. 17, 17*a*.

MEASUREMENTS.

Height . .	20 mm. (approx.).
Width .	6 „
Apical angle .	15°

The shell is of small size, elongately turreted in shape, composed of about two whorls forming a high, elevated spire and a short body whorl.

Embryonic whorls not observed.

The spire consists of about 9 rather high and flat whorls which, however, only slowly increase in height, being separated by a sharp and deep suture. The ornamentation consists of numerous, very regular, sharply raised, somewhat oblique longitudinal ribs, following each other at regular intervals, which are either slightly broader, or of about the same breadth as the ribs; at about two-thirds of their length the ribs are intersected by a deep furrow running parallel to the suture.

The body whorl exhibits the same ornamentation as the spire whorls, only that the ribs are a little closer set.

Aperture not well observed, rather small; columella short, twisted, set with a strong spiral fold behind which is a deep furrow.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Remarks.—The shape of the shell as well as the character of the ornamentation agree so exceedingly well with the living *Terebra duplicata*, Linné sp., that I felt inclined to identify it with this species. *Terebra duplicata* is, however, distinguished by a much larger size and a coarser ornamentation, and as I had repeatedly occasion to remark on the relation between a fossil and living species exhibiting the same features, that in the living species they were stronger developed than in the fossil one, I think that *Terebrum protoduplicatum* must be the direct ancestor of *Terebra duplicata*.

Under the name *Terebra bandangensis*, K. Martin describes a species which is very probably identical with *Terebrum protoduplicatum*, at least it seems to me that according to the figure, the shape and the ornamentation of the shell are exactly alike. K. Martin states, however, that *Terebra bandangensis* has the greatest similarity with *Terebra dimidiata*, Lamk., but on comparing Reeve's figure of that species with that of *Terebra bandangensis*, the differences in the ornamentation are of so startling a character, that I think Martin's figure which is enlarged was not well depicted, otherwise I cannot understand how such an acute observer as Professor Martin could find any similarity between two such widely different species as *Terebra bandangensis* and *Terebra dimidiata*. The figure of the former species shows a shell covered uniformly all over the whorls with numerous rather sharp longitudinal ribs, intersected at about two-thirds of their length by a revolving furrow. According to the description the shell is covered with longitudinal striæ (=Streifen), the strength of which decreases with advancing age, so that on the body whorl they appear only as moderately developed striæ of growth. The description is distinctly at variance with the figure, while it unquestionably fits to the features exhibited by *Terebra dimidiata*, Linn.[1] The figure of *Terebra bandangensis* must therefore be wrong, and I further think that if it would look as depicted, it would seem strange that Professor Martin would have compared it with *Terebra dimidiata* and not with *Terebra duplicata* with which the figure of *Terebra bandangensis* shows the greatest similarity. *Terebra herklotsi*, K. Martin, seems to be another species which has a great similarity with *Terebrum protoduplicatum*, and in figure at least with *Terebra bandangensis*.

Terebra smithi, Martin, appears to be also related to *Terebra protoduplicata* and Professor Martin compares it with *Terebra bernardii*, Desh. I confess that I myself considered *Terebrum protoduplicatum* as a close relative of *Terebra bernardii*, but unless the specific differences of *Terebra duplicata* and *Terebra bernardii* are set forth better than in Reeve's monograph, nothing can be said about its relation to the fossil *Terebrum protoduplicatum*.

TEREBRUM SMITHI, K. Martin, Pl. XXII, figs. 18, 18*a*.

1883-87. *Terebra smithi*, K. Martin, Tiefbohr. auf Java. Beitr. zur Geolog. Ostasiens und Australiens, 1st ser., Vol. III, p. 71, pl. V, fig. 74.

1895. *Terebra fuscata*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 39, pl. IX, figs. 3, 3a (non 4)

MEASUREMENTS.

Height	.	?
Width	.	?
Apical angle		18°

None of the specimens under examination is completely preserved, but it does

[1] I may, however, remark here that the specimen of *Terebrum dimidiatum* from the Indian Ocean which I examined shows the longitudinal ribs so faintly developed that they have already disappeared when the shell does not show a larger width than 1·6 mm. On the other hand, *Terebrum muscarium*, Lamk., exhibits the longitudinal ribs for longer time before they die out to be replaced by striæ, and I think if *Terebrum bandangensis* exhibits the characters as stated by Martin, it is nearer related to *Terebrum muscarium* than to *Terebrum dimidiatum*.

not appear as if the shell attained a large size, because the apical angle is rather large.

The shell was apparently elongately turreted in shape, consisting of rather high, but flat whorls, which slowly increase in height and are separated by a sharp suture. The ornamentation consists of numerous longitudinal ribs, separated by broad interstices. A deep furrow which runs at about two-thirds of the height parallel to the suture divides the ribs into two sets. On the anterior portion the ribs are rather long, slightly curved, on the posterior one short and straight.

Aperture not observed.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.

Remarks.—This species bears a great resemblance to ***Strioterebrum protoduplicatum***, in fact it almost seems as if it were impossible to separate the two species, the character of the ornamentation being almost the same. On closer comparison some differences can, however, be discovered which seemed to justify a specific distinction. In ***Strioterebrum protoduplicatum*** the anterior ribs seem to be straight and not curved as in ***Terebrum smithi***, while the posterior ribs appear to be longer and less reduced as in the last named species; the band set off by the posterior revolving furrow seems also broader in ***Strioterebrum protoduplicatum*** than in ***Terebrum smithi***.

In my former memoir I was of the opinion that the longitudinal ribs became weaker with increasing size and were eventually reduced to mere striæ. I supposed that the fragment of a large shell, fig. 4, represented the same species as fig. 3. I have since convinced myself from a closer comparison with living species that this view, which led me to suppose that the specimen under description is identical with *Terebra fuscata*, Bron., is erroneous. The name of *Terebra fuscata* must therefore be changed as well as fig. 4 be described separately.

Among the numerous species described, ***Terebra smithi***, K. Martin, is unquestionably identical with the species here examined; the shape of the shell and the character of the ornamentation agree so well, that I have no doubt as to the identity.

I have not been able to find any living relative among the fauna of the Indian Ocean and ***Terebrum smithi*** may perhaps represent an extinct type.

TEREBRUM, SPEC. 1, Pl. XXII, figs. 19, 19*a*.

A single fragment of a very elongate shell which by its shape and the character of ornamentation seems to differ from all other species has been examined.

The shell was apparently of rather a large size, very elongately turreted in shape, as the apical angle is barely 8°.

The spire whorls are perfectly flat, rather high, and being separated by a sharp, well-marked suture, increase slowly in height. The ornamentation consists of numerous, equidistant longitudinal ribs, separated by rather broad interstices; the

larger anterior part of the ribs is moderately curved, while the shorter posterior part is straight; on the earlier spire whorls each rib is directly in continuation of one of the preceding whorls, but on the penultimate and body whorl frequently another secondary rib, which has no continuation in apical direction, appears between two primary ribs.

The posterior furrow is hardly seen; in fact it is marked only by a slight concavity of the surface at the point where the ribs change their direction.

Body whorl low, exhibiting the same ornamentation as the spire whorls; columella short, twisted, having apparently a single collumellar fold.

Aperture not observed.

Geological occurrence.—

Zone of *Paracyathus caeruleus*, Yenangyat.

Remarks.—This species exhibits such a great likeness to *Strioterebrum protoduplicatum* and *Terebrum smithi* that it was with some hesitation that I separated it. But if carefully compared with these two species, it will be seen that it differs by a much more cylindrical shape of the shell, that is to say, has a much smaller apical angle; but the chief difference exists with regard to the posterior furrow which is well developed in all the species here described, while it is scarcely indicated in *Terebrum* spec.

These characters are quite sufficient to distinguish it from any of the others, and to prove it to be a new species, but owing to its fragmentary state I refrained from giving it a new name.

SUBULA, SPEC., Pl. XXII, fig. 20.

1895. *Terebra fuscata*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 39, pl. IX, fig. 4 (non 3, 3a).

Only a few fragmentary specimens of this species have come under examination, but the characters exhibited are sufficient to prove that they represent a species different from those hitherto described.

The shell must have been of large size, because the largest specimen has a width of about 15 mm. while the apical angle appears to be very small.

The whorls are flat, rather high and separated by a deep suture; a sharp and deep furrow which runs at about two-thirds of the height, parallel to the suture, sets off a large and broad posterior band. The ornamentation consists of numerous engraved, elongately S-shaped lines.

Aperture not observed.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.
Zone of *Aricia humerosa*, Thayetmyo.
Zone of *Cytherea erycina*, Prome.

Remarks.—It is most unfortunate that the few specimens which have come under examination are in such a fragmentary state of preservation, that it is imposible to say anything more about the relationship of this species. It is

unquestionable that by its size, but particularly by the smooth surface of the whorls, destitute of any longitudinal ribs and exhibiting only striæ of growth, this species differs from all the other species here described. On the other hand the probability that the fragments represent the youngest whorls of a species which on the earlier whorls was provided with longitudinal ribs cannot be denied. Instances of species like *Terebra dimidiata*, Lin., or *Terebra muscaria*, Lmk., which exhibit strong longitudinal ribs on the earlier whorls, and become smooth afterwards are frequent. It seems to me very probable that the specimen of *Terebra bandangensis*, figured by K. Martin, pl. IV, fig. 10, is identical with the species here described. If this be the case, it would be identical with *Terebra bandangensis*. Doubts may, however, be permitted whether Professor Martin's view that fig. 10 represents the younger and fig. 9 the earlier whorls, is correct. None of the specimens figured exhibits that ornamentation which is said to characterize *Terebra bandangensis*, viz., longitudinally ribbed earlier, and smooth later whorls. Fig. 9 which apparently exhibits the body whorl is ribbed throughout, while fig. 10 shows only the striæ of growth, but no longitudinal ribs. The probability that figs. 9 and 10 represent not different stages of one and the same species, but different species altogether, is not entirely disproved by the existing evidence, and a revised examination of *Terebra bandangensis* would be advisable.

Genus: PLEUROTOMA, Lamarck.

The genus *Pleurotoma* has been split up by zoologists into a number of sub-genera, and though nobody examining a larger number of species will deny the justification of such a procedure, it is extremely difficult for the palæontologist, who has only in rare cases well preserved specimens to examine, to decide to which sub-genus a given species belongs. But when the specimens which are to be examined are not well preserved, it is almost impossible to decide on its proper position.

On the following pages ten species have been described which represent five different sub-genera, *viz.*:—

Pleurotoma, s.s., Lamarck.
  1. *Pleurotoma karenaica*, spec. nov.

Surcula, H. and A. Adams.
  2. *Surcula feddeni*, Noetling.

Genota, H. and A. Adams.
  3. *Genota irravadica*, Noetling.

Clavatula, Lamarck.
  4. *Clavatula munga*, spec. nov.
  5. " *fulminata*, Kiener.
  6. " *protonodifera*, spec. nov.

Drillia, Gray.
  7. *Drillia yenanensis*, Noetling.
  8. " *protointerrupta*, spec. nov.
  9. " *promensis*, spec. nov.
  10. " *protocincta*, spec. nov.

From the above list it is obvious that a synoptical table would be inopportune inasmuch as only two sub-genera are represented by more than one species, *viz.*, *Clavatula* and *Drillia*.

The sub-genus *Clavatula* includes a large number of species which appear to be distinguished by such a large variety of features that it is almost impossible to find characters common to all. Bellardi in his splendid monograph enumerates the features by which *Clavatula* is to be recognized, but I cannot help thinking that the definition is rather vague.

I described here three species, two of which, *Clavatula munga* and *Clavatula fulminata*, are so closely related, that at the first glance they might be considered as identical; they are, however, readily distinguished by a deep broad fissural furrow which is visible on all the whorls of *Clavatula fulminata*, while if present at all in *Clavatula munga*, it exists only during the brephic stage and disappears soon, the whorls thereby becoming plane and eventually convex.

Clavatula protonodifera on the other hand represents a perfectly different group, by possessing a granulated keel on the anterior end of the whorls which persists in the ephebic stage, while in the two previous species it is in existence during the brephic stage only; this feature is ascertained for *Clavatula fulminata* while it is very probably existent in *Clavatula munga*.

The three species can therefore be distinguished as follows:—

A. Granulose keel existing only during the brephic stage.
- (*a*) Surface of whorls concave.
  - 1. *Clavatula fulminata*, spec. nov.
- (*b*) Surface of whorls plane or convex.
  - 2. *Clavatula munga*, spec. nov.

B. Granulose keel persistent.
  - 3. *Clavatula protonodifera*, spec. nov.

The sub-genus *Drillia* is characterised by species having a short body whorl in comparison to a long turreted spire, and the four species here described represent almost as many groups. These species can be distinguished as follows:—

A. Surface of whorls with revolving keels.
- (*a*) Only two, sharp smooth keels.
  - 1. *Drillia protocincta*, spec. nov.
- (*b*) Several keels, one of which is granulose.
  - 2. *Drillia yenanensis*, Noetling.

B. Surface with strong longitudinal ribs.
  - 3. *Drillia protointerrupta*, spec. nov.

C. Surface with numerous fine revolving chords intersected by fine longitudinal ribs.
  - 4. *Drillia promensis*, spec. nov.

K. Martin enumerates 36 species altogether from Miocene beds of Java and Sumatra; it seems very remarkable that none of the species here described exhibits any similarity with any of those species; the only species which bear a distant

resemblance are *Surcula feddeni* and *Surcula bantamensis*, Martin; the latter species exhibits the same ornamentation of the spire whorls, *viz.*, four strong revolving chords separated by rather broad interstices, but the species from Java appears to have a perfectly different shape.

The relationship of these ten species is rather a remarkable one, no living relatives could be traced of six, *viz.*, *Pleurotoma* (*s.s.*) *karenaica*, spec. nov., *Surcula feddeni*, Noetling, *Genota irravadica*, Noetling, *Clavatula munga*, spec. nov., *Drillia yenanensis*, Noetling, *Drillia promensis*, spec. nov., though it is possible that a few may have their nearest relatives among the fauna of the Miocene of Java, and they may even be identical; it is very probable that they represent extinct types, the nearest relatives of which occur in the older Tertiary beds.

One species, *Clavatula fulminata*, is identical with the living species of the same name, while two others, *Clavatula protonodifera*, spec. nov., *Drillia protocincta*, spec. nov., are so closely related to living species, differing only by smaller size and more delicate ornamentation, that they must be considered as their direct ancestors.

The last named species, *Clavatula protonodifera*, spec. nov., is the most interesting of all; while it is certain that it represents the permanent neanic stage of the living *Pleurotoma nodifera*, Lmk., it is almost equally certain that it is identical with *Pleurotoma tenuis*, Gray, which is at present restricted to New Guinea.

Pleurotoma (s. s.) karenaica, spec. nov., Pl. XXII, figs. 21, 21*a*.

Measurements.

Height	16 mm.
Width	6 „ (approx.).
Apical angle	32°

The shell is of small size, fusiform in shape and composed of a high turreted spire and a fairly high anteriorly strongly contracted body whorl.

Embryonic whorls not observed.

The spire consists of not less than 7 flat, fairly high whorls, which increasing slowly in height, are separated by an ill-marked suture. The posterior portion of the surface is deeply excavated by a rather broad furrow, corresponding to the labral slit, and marked with numerous, closely set curved striæ of growth, but there is no detached keel close to the suture. The ornamentation consists of three revolving keels of different strength and appearance; No. 1 and No. 2 are close to the anterior end just above the suture; both are smooth, rounded and separated by a very narrow, sharply engraved furrow; No. 3, which is separated by a slightly broader interstice from No. 2, is thick, almost of the strength of Nos. 1 and 2 taken

together, rounded and set with strong regular granules separated by narrow intervals; immediately behind No. 3 follows the furrow which is set with a number of fine granulose chords.

The body whorl occupies about half of the total height; its posterior part is ventricose and rather low; anteriorly it is suddenly contracted, terminating in a long basal canal. The ornamentation differs somewhat from that of the spire whorls; the thick keel No. 3 is split up in two parts by a fine furrow, indications of which could just be noticed on the penultimate whorl; Nos. 1 and 2 which are a little wider apart have become granulose, and in front of No. 1 there is another granulose keel, marking the point at which the body whorl suddenly contracts. The basal canal is covered with a number of strong, equidistant granulose revolving keels separated by rather broad interstices.

Aperture not observed, probably square; anterior canal long and narrow.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

*Remarks.—*At the first glance this species might be mistaken for *Pleurotoma protonodifera*, but a closer examination will prove that it differs by its ornamentation, consisting of a strong granulose keel, in front of which there are two other ones, smooth on the spire, but granulose on the body whorl, and there is no keel behind the furrow. In *Pleurotoma protonodifera* we have only one granulose keel close to the anterior end, but a strong smooth keel behind the furrow.

K. Martin described two species, *Pleurotoma woodwardi* and *Pleurotoma coronifera*, which, as the author himself states, are so closely related to each other that a specific distinction appears difficult; at the first glance both seem very similar to the species under examination. Particularly if it were supposed that the suture runs between keels Nos. 2 and 3, in other words, that keel No. 3 would be No. 1, and Nos. 1 and 2 would be Nos. 2 and 3, or that keels Nos. 1 and 2 instead of being on the anterior end of the whorl, would be at the posterior one. I could, however, ascertain that the suture runs as above described and that the sequence of the keels is as stated. *Pleurotoma karenaica* is therefore easily distinguished from both *Pleurotoma woodwardi* and *Pleurotoma coronifera*, by the absence of keels at the posterior end, and by their presence at the anterior one.

Among the living species *Pleurotoma kienerii*, Reeve, from the Indian Ocean, seems closely related, having also few keels in front of No. 3; these keels are, however, rather sharp and thin, not rounded as in *Pleurotoma karenaica*, separated by broad concave interstices which bear a few filiform chords; keel No. 3 is distinctly subdivided into three finer ones, the concave band behind it is covered with sharply raised chords, separated by rather broad interstices; along the posterior end runs a rather strong and sharp keel, which is particularly conspicuous on the earlier spire whorls. It seems therefore rather doubtful whether there is really a relationship between *Pleurotoma kienerii* and *Pleurotoma karenaica*.

I have not been able to discover any other relatives of this species, which probably represents an extinct type.

SURCULA FEDDENI, Noetling, Pl. XXII, figs. 22, 22*a*, 23, 23*a*, 24, 24*a*.

1896. *Fasciolaria feddeni*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1896, Vol. XXVII, p. 35, pl. VIII, figs. 4, 4*a*.

1895. *Pleurotomo interrupta*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, Vol. XXVII, p. 41, pl. X, figs. 1, 1*a*. (non fig. 2).

No complete specimens have come under examination. Nothing can therefore be said with regard to the measurements, though it seems that the shell did attain only a moderately large size. Its shape is fusiform, and it is composed of a high elevated spire and a long anteriorly contracted body whorl.

The spire whorls are ventricose, hexangular in horizontal section, and separated by a deep, somewhat undulating suture. The ornamentation consists of six thick, rounded longitudinal ribs separated by broad concave interstices, and five somewhat angular revolving keels of moderate strength, four of which are restricted to the anterior portion, while separated by a broad smooth band, the fifth runs close to the suture. The anterior keels are separated by broad interstices, set with very fine revolving lines. The posterior part of the surface which is slightly concave is free of any ornamentation and forms a very characteristic smooth band which on the body whorl bears fine concavo striæ of growth.

The body whorl is rather high, ventricose at the posterior, contracted at the anterior end. The ornamentation is the same as on the body whorl, only that the whole surface in front of the smooth band is covered with revolving keels. Anterior canal apparently rather long.

Aperture not observed.

Geological occurrence.—

Zone of *Paracyathus caeruleus*, Yenangyat.
Zone of *Cancellaria martiniana*, Minbu.
Zone of *Arca theobaldi*, Kama.

Remarks.—In my previous memoir I described this species as a *Fasciolaria*, but having since discovered the concave striæ of growth on the smooth band of the posterior part of the whorls, indicating a slit at the aperture, the generic name must be changed as it unquestionably belongs to the genus *Pleurotoma*.

The specimen which I figured on pl. X, figs. 1, 1*a*, under the name of *Drillia interrupta* has, on comparison with the better preserved specimens from Kama, proved to be identical with this species.

Surcula feddeni has a distant relationship with *Pleurotoma* (*Surcula*) *bantamensis*, K. Martin, inasmuch as the ornamentation of the whorls appears to be the same. The species from Java differs, however, by a different shape of the shell.

I have not been able to discover any further living or fossil relatives, and *Surcula feddeni* most probably represents an extinct type.

GENOTA IRRAVADICA, Noetling, Pl. XXII, figs. 25, 25*a*, 26, 26*a*.

1895. *Pleurotoma (Cryptoconus) irravadica*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, Vol. XXVII, p. 41, pl. IX, figs. 6, 6a.

The three specimens which have come under examination are rather fragmentary, and no measurements could be taken, but it seems that the shell attained a fairly moderate size. Its shape is mitriform, being composed of a high spire and a very high body whorl.

Embryonic whorls not observed.

Only two spire whorls are preserved; these are slightly angular, rather high, and quickly increasing in strength are separated by a sharp suture. An indistinct rounded keel, which runs near the suture, sets off a small posterior part, gently sloping towards the suture from a larger anterior one. The keel which corresponds to the labral slit is set with about six fine revolving chords separated by linear interstices; behind those, and close to the suture, are two strongly raised linear revolving keels separated by a furrow of the same breadth as one of the keels. The anterior portion bears about five fine, revolving keels separated by broad interstices. These keels are crossed by faint longitudinal ribs, which are somewhat irregular in strength and separated by fairly broad intervals, produce ill-marked nodules at the point of intersection.

The body whorl is very high, flattened and only slightly accuminate in anterior direction. The ornamentation is the same as on the spire whorls, only that according to the greater height of the anterior portion, there are about 12 strong revolving keels separated by broad interstices.

Aperture not observed.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.

Zone of *Cancellaria martiniana*, Minbu.

Remarks.—This species is easily distinguished by its mitriform shape, and peculiar ornamentation from all the others here described. Though having carefully searched for any species which could be compared to *Genota irravadica*, I failed to discover any relatives; there is therefore the greatest probability that it represents an indigenous type which is extinct among the living fauna of the Indian Ocean, but most probably has its nearest relatives in the fauna of the older Tertiary beds.

CLAVATULA MUNGA, spec. nov., Pl. XXIII, figs. 1, 1*a*.

MEASUREMENTS.

Height . .	46 mm. (approx.).
Width . .	20 "
Apical angle .	50°

The shell is of a fairly large size, fusiform in shape, consisting of a high turreted

spire, and large ventricose body whorl, abruptly contracted and terminating in rather a short canal.

Embryonic whorls not observed.

The spire consists of probably 7 to 8 fairly high whorls which increasing slowly in height are separated by a sharp suture. The earlier whorls are slightly concave, but they become gradually flat and the penultimate whorl is fairly bulging out. The ornamentation consists in numerous very fine regular revolving lines which apparently cover the whole surface and are separated by finely engraved interstices.

The body whorl is large and occupies a little over half of the total height; the posterior end is broad, inflated but distinctly flattened; anteriorly it is suddenly contracted and terminates in a short canal, which equals in height the posterior part. The ornamentation was probably the same as on the spire whorls, but it is also probable that the surface was smooth and exhibited only striæ of growth. The striæ of growth are numerous, very closely set and form a deep and broad sinus, which is situated slightly behind the middle of the posterior portion of the surface.

Aperture not well seen, but probably rather small, obscurely rectangular in shape; the anterior canal is very short and narrow.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—The only specimen which has come under examination is unfortunately considerably rolled and worn. It was therefore only by the merest accident that the ornamentation of the spire whorls remained preserved on a small part, but it is impossible to say whether this ornamentation also extended on the body whorl, or whether its surface is smooth as it appears to have been.

Clavatula munga is easily distinguished from all the other species here described by an almost smooth surface, destitute of any longitudinal ribs or tubercles, it bears, however, a great resemblance to *Clavatula fulminata*, but though the shape is much the same, it differs considerably with regard to the whorls and their ornamentation. In *Clavatula fulminata* the whorls remain concave throughout, even the body whorl exhibits a broad though flat furrow on its posterior part; in *Clavatula munga*, only the earlier whorls are concave, the middle spire whorls are flat and the penultimate as well as the body whorl are ventricose. In *Clavatula munga* the ornamentation consists of very fine revolving keels, separated by linear engraved interstices; in *Clavatula fulminata* the anterior part of the earlier spire whorls is set with short tubercles, and the revolving keels are limited to the concave part of the surface only.

Clavatula munga unquestionably represents a type which is extinct among the present fauna of the Indian Ocean, and as I have not been able to discover any fossil relatives, it is probably a species which has its relations in the older Tertiary beds of India.

Clavatula fulminata, Kiener, Pl. XXIII, figs. 2, 2a.

1843. *Peurotoma fulminata*, Reeve, Monograph of the Genus *Pleurotoma*, pl. V, fig. 37.

The only specimen which has come under examination is partly mutilated, and as it is still imbedded in the matrix from which it could not be freed without breaking it, no measurements could be taken.

The shell attained, however, a fairly large size, as the fragment measures 29 mm. in length; it is fusiform in shape, composed of a high and turreted spire and a body whorl terminating apparently in a short canal.

Embryonic whorls not observed.

There are three spire whorls preserved, which are rather high, but increase slowly in height and are separated by a sharp suture. The surface of the whorls is concave, from a broad flat furrow which on the earlier whorls runs apparently in the middle, but shifts its place on the later whorls somewhat in posterior direction; on the earlier whorls the furrow is rather deep, but becomes gradually flatter. The earlier spire whorls differ considerably from the later ones with regard to the ornamentation; on the earlier ones there is a single line of strong, a little oblique, tubercles on the anterior part of the surface, quite close to the suture. These tubercles have perfectly disappeared on the penultimate and the preceding whorl which are therefore perfectly smooth, except for the revolving ornamentation. The earlier whorls seem to be covered all over the surface with very fine revolving chords, separated by linear interstices, the number of these chords apparently decreases with advancing age, and with the disappearance of the tubercles, the chords become more and more restricted to the concave central part of the surface. On the penultimate whorl their number is still more reduced and the greater part of the surface has become smooth; on the other hand, numerous closely set, very regular striæ of growth become more prominent than on the preceding whorls.

The body whorl is fairly large, its length being probably the same as that of the spire; the posterior part is broad and inflated, the anterior one contracted, forming an apparently short canal. The furrow excavating the surface has become very flat, though it is still quite distinct and runs now close to the suture, above the labral slit. The posterior part of the surface is almost smooth; only a few indistinct revolving chords can be seen in the furrow, while on the other part, faint engraved lines, separated by rather broad interstices, become visible. The anterior contracted part is covered with a number of fairly strong, rounded keels, separated by broad interstices which are filled up by fine, little sinuous lines. The striæ of growth are numerous, closely set, but very regular and fine, forming a broad and deep sinus, the apex of which is just in front of the furrow.

Aperture not observed.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.

Remarks.—This species is so closely related to *Clavatula munga* that at the

first glance it might be mistaken for that species. It is, however, easily distinguished by the concave whorls, a feature which is still well seen even on the body whorl. In addition to this, the ornamentation readily distinguishes *Calvatula fulminata*, though I admit that it will be difficult to separate rolled specimens of both species. But as it seems that *Clavatula munga* occurs only in the zone of *Parallelipipedum prototortuosum*, while *Clavatula fulminata* is restricted to the zone of *Mytilus nicobaricus*, and as in both horizons no similar species occurs, the determination even of rolled specimens should not be doubtful.

I have been able to compare a specimen of *Clavatula fulminata* from the Indian Ocean which, though it appears to be slightly rolled, exhibts exactly the same characters as described in the fossil specimen; the broad furrow which canaliculates the whorls and which persists up to the aperture is as well marked as the row of granules at the anterior end of the spire whorls, and the anterior part of the body whorl exhibits the same revolving striæ, the interstices of which are occupied by finer ones as noticed on the fossil specimen.

CLAVATULA PROTONODIFERA, spec. nov., Pl. XXIII, figs. 3, 3a, 4, 4a.

1895. *Pleurotoma voysei*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 40, pl. IX, figs. 5, 5a.

None of the specimens is sufficiently well preserved to allow for measurements, but it seems that the shell attained only a moderate size. It is fusiform in shape, composed of a high turreted spire and a low body whorl, terminating apparently into a short basal canal.

Embryonic whorls not observed.

The number of spire whorls could not be ascertained, but they seem to have been fairly numerous, rather high and separated by an indistinct suture; the surface is deeply excavated by a broad furrow running on the posterior part, close to the suture, but being separated from it by a strong angular revolving keel. The ornamentation consists of a line of laterally compressed, very short longitudinal ribs, on the anterior part close to the suture. These ribs, which on the earlier whorls take the shape of tubercles, are slightly oblique and are separated by regular equidistant intervals. The whole surface is covered with numerous fine revolving chords separated by linear interstices.

The body whorl is apparently short, the posterior part is ventricose, the anterior one contracted, forming an apparently short basal canal. The fine revolving chords are here replaced by somewhat irregular revolving keels.

Aperture not observed.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.

Zone of *Cancellaria martiniana*, Minbu.

Remarks.—In my previous memoir I identified this species with *Pleurotoma voyesi*, d'Archiac and Haime, a view which I think was erroneous, and to which I was led by Messrs. d'Archiac and Haime's rather insufficient figure. *Pleurotoma*

voyesi differs, as I have now found out, by a sharp median keel of which there is no trace in *Clavatula protonodifera*.

Clavatula protonodifera is by its ornamentation easily distinguished from all the other species here described, except *Clavatula munga*, with which it bears a considerable similarity; it is, however, distinguished by a larger size higher whorls, a broader concave part and a simple posterior keel, covered with fine chords. These are the distinguishing features of fragments; if a fully preserved specimen of *Clavatula munga* is examined, there is no doubt as to the specific difference on account of the perfectly different body whorl.

Clavatula protonodifera seems to be closely related, if not identical, with *Pleurotoma grissensis*, K. Martin. Description and figure seem to agree so well that for a long time I felt inclined to identify both species. Yet it seems to me as if there existed differences; Martin does not mention a posterior keel running close to the suture, but such a keel exists unquestionably in *Clavatula protonodifera*, though it is only distinctly visible in the smaller specimen, while it is not quite so clear in the bigger one. If this keel is really not present in *Pleurotoma grissensis*, its absence would constitute a good distinctive feature, but if future researches—Professor Martin examined only a single specimen,—should prove that it existed, I think that *Pleurotoma grissensis* must be identified with *Clavatula protonodifera*.

I have been able to compare a specimen of *Pleurotoma nodifera*, Lmk., from the Indian Ocean, and I can only state that there does not exist the slightest difference between the earlier spire whorls of this species and those under examination. The ornamentation of the living specimen consists in a strong rounded revolving keel A, set with thick, somewhat oblique, elongate tubercles, separated by equidistant concave interstices, which runs close to the anterior end; between this keel and the suture, a finer but smooth keel F is visible. Behind keel A follows a smooth, rather broad concave band, covered with fine revolving lines, and close to the posterior end runs a strong revolving keel P which is simple on the earlier whorls, but very soon splits up in two finer ones P″ and P′ (see fig. 4, page 352).

The above description of the neanic stage of the living *Pleurotoma nodifera* is exactly the same as that of the fossil species, and the only differences I can discover are perhaps the more concave whorls, the better marked revolving lines, and the slightly stronger posterior keel P, which does not appear to split up. This ornamentation persists apparently in the fossil species, but in the living one it undergoes a certain change, which cannot be disregarded.

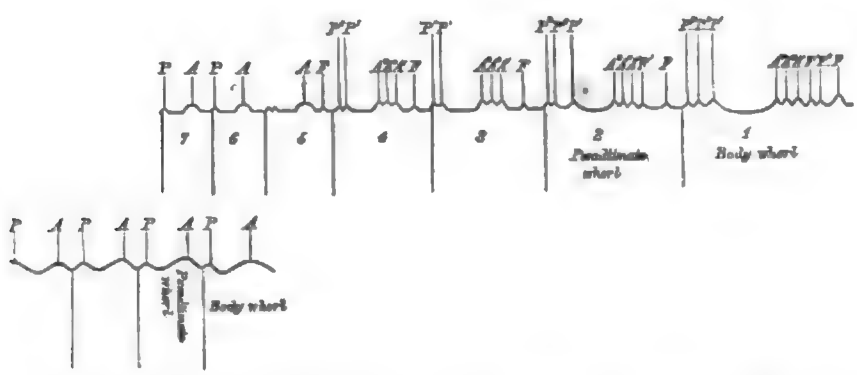
In the first instance the oblique tubercles on the anterior keel become more and more weaker, till they have almost disappeared on the body whorl. Hand in hand with this goes a splitting up of the keels; this tendency is at first indicated by three fine lines separated by rather broad interstices (see whorl 4; A′ A″ A‴), both become more marked with advancing age, a finer chord F′ appears in front, and on the penultimate whorl the homogenous keel of the neanic stage is divided into four fine and smooth revolving chords, A‴ A″ A′ F′, which by their undulating appearance still indicate the former existence of the tubercules; the interstices separating the chords are rather broad deep furrows.

On the body whorl the keel has entirely disappeared and is replaced by four smooth flat keels of almost the same strength, A''' A'' A' F', in front of which there is a fifth finer one, F'', which has appeared on the latter half. The originally strong granulose keel has thus on the body whorl become modified into a number of finer ones, similar to those which cover the anterior part of the body whorl.

The posterior keel which is simple on the earlier spire whorl exhibits very soon a fine furrow (whorl 5) which gradually divides in two, P'' and P' (whorl 4); on the penultimate whorl the posterior keel is again sub-divided, and on the body whorl there are, instead of a thick one, three fine chord-like keels, P''' P'' P', decreasing in strength in posterior direction, separated by broad interstices.

The changes which the ornamentation of the whorls undergo during the different evolutionary stages will be seen best from the following diagram, the upper figure representing *Pleurotoma nodifera*, the lower one *Clavatula protonodifera* :—

Fig. 4.



In view of the above differences of ornamentation I think it better to distinguish the fossil species which unquestionably represents the permanent neanic stage of the living *Pleurotoma nodifera* under a separate name.

Under the name of *Pleurotoma nodifera*, K. Martin described a species from Java, which is unquestionably different from *Clavatula protonodifera*. Martin's figure shows the subdivision of A into apparently three secondary keels, distinctly on the body and penultimate whorl, but it is not quite clear whether the earlier whorls are equally divided. On the other hand, Martin's figure shows only a simple keel P, but though Martin states that the specimens examined by him are exactly alike the living species, I cannot bring this ornamentation in accordance with that observed in the living specimens I examined. It rather seems to me that *Pleurotoma nodifera*, K. Martin, occupies by its subdivided anterior keel A and its simple posterior keel P a medium position between *Clavatula protonodifera*, having both keels A and P undivided and *Pleurotoma nodifera* where both A and P are subdivided.

Though I have no doubt that *Pleurotoma protonodifera* represents the permanent neanic stage of *Pleurotoma nodifera*, yet there is another species, *Pleurotoma tenuis*,

Gray (=*corrugata*, Kien), from New Guinea, which appears identical with *Clavatula protonodifera;* unfortunately I am not in the position to compare a living specimen, but to judge from Reeve's figure, the similarity is so great that it is impossible to find any other differences, except that it seems that on the spire whorls the granulose keel is a little farther away from the suture than in *Clavatula protonodifera*.

The result of the above considerations could be expressed in the following table:—

	India—Burma.	New Guinea.
Recent .	*Pleurotoma nodifera* .	*Pleurotoma tenuis.*
Miocene .	*Pleurotoma protonodifera.*	

This would mean that in the Miocene of Burma a species, *Clavatula protonodifera*, exists which has its direct descendants among the fauna of the Indian Ocean in *Pleurotoma nodifera:* at the same time *Pleurotoma protonodifera* migrated eastwards where it probably still exists as *Pleurotoma tenuis*, having apparently hardly changed its characters during this migration. If this view be correct, the specific name *tenuis*, Gray, should be substituted for *protonodifera*, Noetling, but the question must remain in abeyance till specimens of *Pleurotoma tenuis* and *Pleurotoma protonodifera* can be compared.

DRILLIA YENANENSIS, Noetling, Pl. XXIII, figs. 5, 5a.

1895. *Pleurotoma yenanensis*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, Vol. XXVII, pl. X, figs. 3, 3a.

The only specimen which has come under examination is rather fragmentary; as it measures about 20 mm. in height the shell must have attained a moderate size. It is turreted in shape and composed of a high spire and a low body whorl, which terminated apparently in a very short basal canal.

Embryonic whorls not observed.

There are four slightly inflated, rather high spire whorls, which slowly increase in height and are separated by rather an indistinct suture. The ornamentation consists of four primary revolving keels, all different in strength. No. 1, which is the most anterior, runs close to the suture; it is finer than No. 2 which is sharp, strongly raised and separated from No. 1 by a broad slightly concave interstice. No. 3 is rather lower than No. 2, but chiefly differs by being set with low, rounded nodules separated by rather broad intervals. No. 4 is the finest and lowest of all, very close to the suture and separated by a broader interstice from No. 3 than the latter is from No. 2. All the interstices are set with filiform chords, separated by rather broad interstices, and varying in number according to the breadth of the interstices between the primary ribs. The revolving ornamentation is intersected by numerous, very fine, but somewhat irregular closely set, longitudinal lines which are, however,

only distinctive in the interstices between the primary ribs. These lines which probably represent the striæ of growth run obliquely from left to right between keels Nos. 1 and 3 and in opposite direction between 3 and 4. Keel No. 3 marks thus the position of the labral slit.

The body whorl is rather low, occupying perhaps not more than ⅓rd of the total height; it is inflated and seems anteriorly to terminate in a short basal canal. The ornamentation is the same, only that in front of No. 1 keel there are three similar ones separated by broad interstices.

Aperture not observed.

Geological occurrence.—

Zone of *Paracyathus caeruleus*, Yenangyat.

Remarks.—None of the other species here described could be compared with *Drillia yenanensis*, which, though belonging to the same group as *Drillia protocincta*, is easily distinguished from this species by the larger size and a greater number of revolving keels, one of which differs from the other smooth ones by its granulose character.

I have not been able to find any living or fossil relative of this species which most probably represents a type which is extinct among the present fauna of the Indian Ocean.

DRILLIA PROTOINTERRUPTA, spec. nov., Pl. XXIII, figs. 8, 8*a*, 9, 9*a*, 10, 10*a*.

1883–87. *Pleurotoma* (*Drillia*) *interrupta*, K. Martin, Beitr. Geolog. Ost. Asiens und Australiens, 1st ser., Vol. III. p. 65, pl. X, figs. 66, 67, 68.

1895. „ „ „ Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, Vol. XXVII, p. 41, p. X, fig. 2 (non. 1, 1*a*.) !

MEASUREMENTS.

Height . .	11·5 mm.
Width . .	4· „
Apical angle .	28°.

The shell is of small size, turreted in shape, composed of a high spire and a short anteriorly slightly accuminate body whorl.

There seem to have been three embryonic whorls, two of which were perfectly smooth, while the third one just shows faint longitudinal striæ.

The spire is composed of about seven, slightly ventricose whorls, which though fairly high, slowly increase in height. The suture is undulating and well marked. On the posterior part of the surface a narrow, but deep furrow which corresponds to the lateral slit runs very close to the suture, setting off a well raised rounded keel. The anterior part of the surface is covered with eight thick, rounded longitudinal ribs separated by very narrow intervals. These ribs are very regular, each one being right underneath that of the preceding whorl, and they are crossed by a number of fine revolving chords separated by rather broad interstices.

The body whorl is rather short, occupying less than half of the total height; posteriorly it is ventricose, anteriorly slightly contracted, terminating in a short

basal canal. The ornamentation is the same as on the spire whorls, only that the revolving chords are more numerous and extend right up to the end of the canal.

Aperture not observed, but it seems that the anterior canal though short, was rather broad.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.

Zone of *Arca theobaldi*, Kama.

Remarks.—In my previous memoir I figured an ill-preserved specimen of *Surcula feddeni*, which I believed to be identical with *Pleurotoma interrupta;* having since received better preserved specimens, I have been able to prove that this view is not correct. *Surcula feddeni* though rather similar to the species here described, particularly when only fragmentary specimens have come under examination, is easily distinguished by the long basal canal and much broader posterior furrow.

I have again carefully compared this species with *Drillia interrupta*, and I think there exist certain differences which make it advisable to distinguish it under a separate name. The chief difference exists in the strength of the ribs; in *Drillia protointerrupta* they are thick, strongly raised, there being nine to one volution on the body and penultimate whorl; in *Drillia interrupta* the ribs are rather thin, separated by broad intervals and there are eleven to one volution: these differences are, however, so small that they might be disregarded.

DRILLIA PROMENSIS, spec. nov., Pl. XXIII, figs. 11, 11*a*.

MEASUREMENTS.

Height	15 mm.
Width	4 " (approx.).
Apical angle	20°.

The shell is of small size, ovately turreted and composed of a very high spire and short body whorl.

Embryonic whorls not observed.

There are 7 to 8 rather high flat spire whorls, which increasing slowly in height, are separated by an indistinct suture. On the posterior part of the surface a narrow though deep furrow runs close to the suture, setting off a narrow, angular keel, the posterior side of which is crenulated. The furrow itself is covered with a few extremely fine granulose chords; the anterior part is covered with straight or slightly oblique, rounded longitudinal ribs, separated by intervals of about their own breadth: these ribs are intersected by four revolving keels of about the same strength as the longitudinal ribs, producing on the point of intersection rounded low tubercles.

Body whorl short, occupying less than half the total height; the posterior part is slightly inflated, the anterior one contracted, terminating in a short anterior canal. The ornamentation is the same as on the spire whorls, but the number of revolving keels is larger and the longitudinal ribs terminate at the point of contraction; the surface of the canal is therefore free of any ornamentation, except some irregular revolving striæ. Aperture ill seen, apparently elongately oval, anterior canal short but broad.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Remarks.—The general shape as well as the ornamentation readily distinguish this species from all the others, with none of which it bears any resemblance. I have not been able to discover any species, living or fossil, to which *Drillia promensis* could be compared. It is, therefore, almost certain that this species represents an indigenous type which is extinct among the fauna of the Indian Ocean, and whose ancestors probably occur in the older Tertiary beds of India or Burma.

DRILLIA PROTOCINCTA, spec. nov., Pl. XXIII, figs. 6, 6*a*, 7, 7*a*.

MEASUREMENTS.

Height . .	9 mm.
Width . .	3·5 „
Apical angle .	27°

The shell is of small size, ovate in shape, composed of a high turreted spire and a short slightly contracted body whorl. Embryonic whorls not observed.

There are probably six, rather high, flat spire whorls, which slowly increasing in height are separated by an almost imperceptible suture. The surface is deeply excavated by a broad and deep furrow which occupies almost the whole height of the whorls. The ornamentation consists of two smooth, strongly raised angular revolving keels, the most posterior of which runs close to the suture, while separated by a broad concave interstice, the second one runs exactly in the middle. The surface on either side of the median keel is covered with fine revolving chords, separated by rather broad interstices. There are numerous striæ of growth which appear in the shape of extremely fine plications in the interstices.

The body whorl is rather low, occupying less than ⅓rd of the total height; anteriorly it is slightly contracted, terminating in a short canal; the ornamentation is the same as on the body whorl, only that there are about 8 to 10 revolving keels, none of which reaches the strength of the two posterior ones in front of No. 1 keel. Their interstices are rather broad and filled with fine longitudinal plications.

Aperture not observed; anterior canal short, but apparently broad.

Geological occurrence.—

Zone of *Arca theobaldi*, Kama.

Remarks.—Owing to the indistinctness of the suture and the smallness of the shell, the correct ornamentation of the whorls is difficult to recognise. I think, however, that the way I interpreted it is correct, *viz.*, a posterior keel running close to the suture and an anterior one running exactly in the middle of the height of each whorl.

Drillia protocincta is readily distinguished from all the others here described by its smallness and the ornamentation. Young specimens of *Drillia yenanensis* may perhaps resemble somewhat to this species, but they are readily distinguished by the granulose keel.

Drillia protocincta resembles *Pleurotoma cincta*, Lamarck, from the Indian Ocean so closely that it is difficult to discover any differences; the living

species differs only by a larger size and a stronger ornamentation, and these features are therefore quite in harmony with similar observations made with other species which are considered the direct descendants of Miocene species.

GENUS: CONUS, Linné.

Though the genus *Conus* is one of the most widely distributed genera in the Tertiary rocks, the determination of the fossil species is one of the most difficult tasks, chiefly on account of the indifferent characters the shell affords. As a rule the fossil specimens do not exhibit any colour markings, or if they do, they are certainly of much less systematic value than in the living species. For specific distinction the palæontologist can only refer to the shape of the shell, but so far it seems that no general plan has been adopted by which the numerous species might be distinguished. Anybody going through the description of a number of similar species will be greatly puzzled if he tries to find out by which characters the species really differ.

I think that an exceedingly good distinctive feature is the height of the spire, which may be conveniently expressed by the cosine of half the apical angle. As in very few cases the profile line of the spire is straight, being mostly represented by a curved line, I assume the apical angle to be that angle which is formed by two lines from the apex to the keel of the body whorl. I call this angle α and the height of the apex above a plane laid horizontally through the keel of the body whorl would be represented by cosine $\alpha/2$. It is quite true that owing to the spiral volution a plumb line from the apex to this plane would not quite bisect the apical angle α, but inasmuch as this angle will never be quite constant, this error may be overlooked.

Accepting this view we could distinguish three groups, *viz.* :—

(A)	cosine $\alpha/2$	$\angle$ 0·25, flat spired shells.
(B)	cosine $\alpha/2$	from 0·25 to 0·60, low spired shells.
(C)	cosine $\alpha/2$	from 0·61 to 1, high spired shells.

The above definitions are certainly more precise than the old distinctions between flat and elevated or high spires, which leave too large a field for individual views.

Another feature which seems to me of systematic value is the angle β formed by the two parts of the body whorl, as divided by the revolving keel; in almost all cases this angle will have an extremely short posterior and an unproportionately long anterior side. I certainly found that all the species here described could be easily distinguished by this character, as will be seen from the following table :—

	Angle.	Posterior side.	Anterior side.
Conus literatus	less than 90°	straight	straight.
,, *malaccanus*	obtuse	straight	straight.
,, *avaënsis*	obtuse	flatly concave	straight.
,, *hanza*	obtuse	straight	straight.
,, *yulei*	obtuse	straight	straight.
,, *galensis*	obtuse	very concave	slightly concave.
,, *protofurvus*	obtuse	straight	straight.

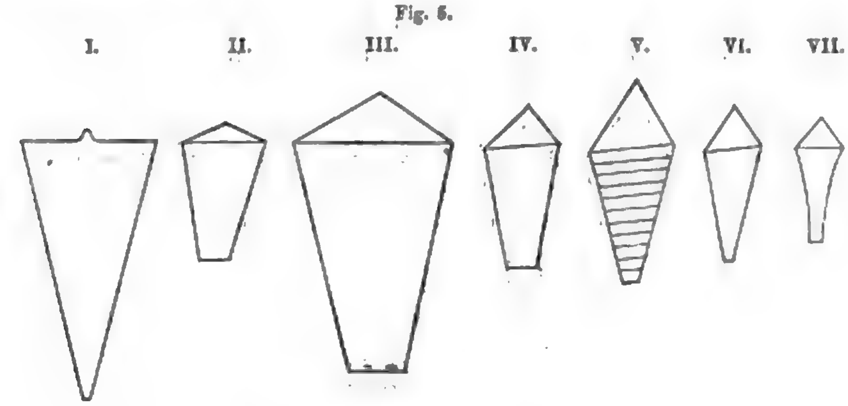
If in each instance the accurate value of angle β could be given, the differences would be more obvious than if only expressed by the rather vague terms "obtuse" and "acute."

It is, however, difficult to obtain the value of this angle with accuracy, except from a longitudinal section.

Another equally valuable feature is the angle γ formed by the anterior sides of the body whorl; as far as I can see this angle is very constant in the species, though further researches would be necessary to prove this view.

If we construct a longitudinal diagrammatic section of each species based on the above three features, we see at once and much better than by the ordinary illustration the difference of a certain number of species, as will be illustrated by the following woodcut :—

Fig. 6.



I. Conus literatus.
II. " malaccanus.
III. " avaënsis.
IV. " hanza.

V. Conus yulei.
VI. " galensis.
VII. " protofurvus.

Of course I do not pretend to say that these characters would exhaustively describe and fix a species; this is by no means the case, as will be illustrated by the diagrams of *Conus hanza* and *Conus protofurvus*, but if, in addition to the above characters, any ornamentation will be mentioned, the description of *Conus* could be given in an exceedingly accurate way, perhaps more precise than of any other genus of Gastropoda.

By carefully examining the above principles in a large number of species, it may, perhaps, be possible to arrive at a sub-division of the genus *Conus*, which would be of value to palæontologists, and not valueless like the present one adopted by the conchologists. The Miocene of Burma has yielded seven species which can be distinguished in the following way :—

A. Cos. $\alpha/2 < 0{\cdot}25$ (spire flat).

1. *Conus literatus*, Linné.

B. Cos. $\alpha/2$ from 0·26 to 0·60 (spire low).

(*a*) Spire turreted, step-like.

2. *Conus malaccanus*, Hwass.

(*b*) Spire conical.

3. *Conus avaënsis*, spec. nov.

C. Cos. $a/2 > 0{\cdot}60$. (Spire moderately high).

(*a*) Both sides of β straight.

(*aa*) Surface of body whorl smooth.

4. *Conus yulei*, spec. nov.

(*bb*) Surface of body whorl covered with engraved lines.

5. *Conus hanza*, spec. nov.

(*cc*) Surface of body whorl only anteriorly covered with engraved lines.

6. *Conus protofurvus*, spec. nov.

(*b*) Sides of β concave.

7. *Conus galensis*, spec. nov.

The relationship of these species is rather varied, two of them, *Conus literatus*, Linné, and *Conus malaccanus*, are unquestionably identical with species inhabiting at present the Indian Ocean, while of the other five it is almost certain that they have no relatives among that fauna. One of them, *Conus avaënsis*, may, perhaps, be related to a species from the Eocene of Paris, while the relatives of *Conus hanza* and *Conus protofurvus* inhabit at present the Eastern Seas. *Conus galensis* most probably represents an entirely extinct type, while *Conus yuleianus* is too ill-preserved to allow of a comparison.

CONUS (LITHOCONUS) LITERATUS, Linné, Pl. XXIII, figs. 12, 12*a*, 13, 13*a*, 14.

1840. *Conus brevis*, J. de Carle Sowerby, Transact. Geol. Soc. of London, 2nd ser., Vol. V, pl. XXVI, fig. 33.
1843. *Conus literatus*, Reeve, Monograph of the Genus *Conus*, pl. XXXIII, fig. 183.

MEASUREMENTS.

Length . . .	52 mm.
Width . . .	23 „
Angle of body whorl .	27°

The shell is of moderate size, accuminated, conical in shape, and composed of about nine whorls forming a very low spire, having apparently an average apical angle of almost 180° and long and high strongly accuminate body whorl.

Embryonic whorls not observed.

Earlier spire whorls unfortunately broken off, but it appears that their surface was steeply sloping towards the suture; the whorls form during the brephic stage, a rather elevated spire, but the angle of slope rapidly decreases and must have become almost zero at the beginning of the neanic stage; thus the posterior part of the spire whorls as well as that of the body whorl are almost in one plane. The whorls imperceptibly increase in height and are separated by a deep suture. On the earlier whorls there are a few engraved revolving lines, but they appear to become effaced on the body whorl, where there are only numerous curved fine concentric striæ of growth.

The body whorl is rather large and high, very regularly conical in shape, divided by a sharp keel into small flat posterior, and a gently sloping anterior portion; a longitudinal section through the body whorl would show a sharp angle of 75° having two straight sides, a very short posterior and a very long anterior one. The surface is smooth except for numerous fine striæ of growth bending sharply backwards near the posterior keel.

Geological occurrence.—

Zone of *Aricia humerosa*, Thayetmyo.

Remarks.—*Conus literatus* is easily distinguished from all the others here described by a spire so strongly depressed, that it appears almost flat, that is to say, cos. $a/2$ is smaller than 0·25; there appear to be, however, some variations, inasmuch as in one specimen the spire is perfectly flat, while in the other ones it is slightly raised; the living specimens seem to exhibit the same variations, inasmuch as the specimen examined by me shows a perfectly flat spire, while that figured by Reeve has a distinctly raised one. Another distinctive feature is the absence of spiral striæ at the anterior end of the body whorl.

Sowerby has described and figured three species, *Conus brevis*, *Conus militaris* and *Conus catenulatus*, which represent most probably one and the same species; at least better distinctive characters must be given before the specific independence of these three species can be accepted. There is no doubt that *Conus brevis* is identical with the species here described, and I identify the specimens from Burma with that species, should *Conus militaris* and *Conus catenulatus* turn out to be really different.

A specimen of *Conus literatus* from Ceylon which I have been able to compare, shows no difference whatsoever, angles β and γ being almost the same.

CONUS (RHIZOCONUS) MALACCANUS, Hwass, Pl. XXIII, figs. 17, 17*a*, 18, *a*-*b*, 19, 19*a*, 20, 20*a*.

1843. *Conus malaccanus*, Reeve, Monograph of the Genus *Conus*, pl. X, fig. 49.
1895. „ „ Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 42, pl. X, figs. 4, 5, 6, 6a, 7, 7a.

MEASUREMENTS.

Height	25 mm.
Width	13·5 „
Apical angle . .	127°
Angle of body whorl .	25°

The shell is of small size, conical in shape and composed of a short spire and a high, accuminated body whorl. Embryonic whorls not observed.

The spire is composed of not less than 10 whorls, separated by a sharp suture and increase very slowly in height. During the brephic stage the surface of the whorls formed an angle of about 60° with the suture; this angle gradually flattens down, and the profile line of the spire is therefore concave; as each succeeding whorl does not quite reach up to the keel of the preceding one, the spire becomes somewhat steplike, a feature which is very characteristic of this species. The earliest spire whorls appear slightly granulated, because the ends of the short longitudinal ribs which line

the anterior part of the whorls near the keel, rise just above the suture. This feature is, however, only noticed in well-preserved specimens and soon disappears when only a revolving ornamentation, consisting of a few engraved lines which are crossed by numerous striæ of growth, remains visible.

The body whorl is rather large, broad at its posterior, acuminate towards it anterior end. A rounded, though distinctly marked keel, sets off a small posterior portion sloping towards the suture and a larger anterior one sloping in opposite direction. As the posterior part is flat, the profile line is represented by an obtuse angle, the apex of which is rounded, having a short straight posterior and a long straight anterior side. The revolving ornamentation noticed on the spire whorls becomes more marked and stronger. The striæ of growth are numerous and well marked towards the anterior end; a number of weak, revolving keels separated by rather broad interstices are visible.

The aperture is long and narrow, expanded at the anterior, deeply cut out at the posterior end; the outer lip is thick but sharp and cutting.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.

Zone of *Paracyathus caeruleus*, Yenangyat.

Remarks.—In my previous memoir I identified *Conus javanus*, K. Martin, with this species, but I think it preferable to adopt now a nother view. *Conus javanus*, Martin, is unquestionably a close relative of *Conus malaccanus*, the characters of the step-like spire being the same in both species, but on the other hand *Conus javanus* does not show the spiral lines on the anterior part of the body whorl, a feature which is well marked in all the specimens I examined. The absence of this character in *Conus javanus* may be due to the state of preservation, though it appears as if this species is well preserved. My view of the absence of these spiral lines seems to be supported by the description in which they are not mentioned, and if I be correct, this feature would form a good specific distinction from *Conus javanus*, though this species may otherwise be closely related to *Conus malaccanus*.

Professor Martin has recently described another species, *Conus odengensis*, which even seems to have a closer relationship to the species here examined, than *Conus javanus*. Professor Martin himself draws attention to the close relationship of *Conus odengensis* and *Conus malaccanus*, but he is inclined to consider them specifically different, because he did not observe either the twisted columella, or the close spiral striæ on the anterior part of the body whorl of *Conus malaccanus*. The latter character seems to me of no great importance, because as long as the spiral striæ are present, it does not matter whether they are a little closer or wider apart. In the specimen I examined they are certainly not much wider than in the fossil species, but even if the examination of a larger number of fossil and living species would prove that the spiral striæ or lines are habitually closer in the fossil than in the living species, would such a difference which unquestionably has to be considered in an evolutionary light constitute a specific character? I think decidedly not.

A similar argumentation may apply to the twisting of the columella which shows certainly a varying degree in Professor Martin's own figures.

To summarize, I think that the species which I here described under the name of *Conus malaccanus* is identical with the living species, and most probably also with *Conus odengensis* from Java, but in intricate cases like the above, when minute differences may perhaps decide, it must be left to the author to settle for himself which view he will take.

Conus malaccanus is easily distinguished from all the others here described by the peculiar step-like appearance of the low spire, and the granulated earlier spire whorls.

I have carefully compared the specimens under examination with *Conus malaccanus* from the Indian Ocean, and I can find no other difference, but that they do not seem to attain the size of the living specimen; in all other details they are exactly alike it; the living *Conus malaccanus* has an apical angle of 130°, in the fossil one it is 126°, while the angle of the body whorl is 29°, and in the fossil specimen 26°. Still more convincing are the characters of the spire: the granulated keel of the earlier spire whorls is well visible, and the step-like profile of the spire is well marked.

CONUS AVAËNSIS, spec. nov., Pl. XXIII, figs. 15, *a-b*, 16, *a-b*.

MEASUREMENTS.

Height	44 mm.
Width	27 „
Apical angle	118°
Angle of body whorl	28°

The shell is of moderate size, conical in shape and composed of a fairly elevated spire and a high accuminate body whorl.

Embryonic whorls not observed.

The spire is composed of not less than ten whorls separated by a sharp suture, and increases very slowly in height; during the brephic stage the surface of the whorls formed an angle of about 45° with the suture; this angle gradually flattens down up to the penultimate whorl when it becomes a little larger again; the profile line of the spire is therefore S-shaped. The surface is covered with about eight, rounded revolving lines, which are crossed by coarse striæ of growth.

The body whorl is rather large, broad at its posterior, accuminate towards its anterior end. A rounded, though distinctly marked keel sets off a small posterior portion sloping gently towards the suture, and a large anterior one, sloping in opposite direction. As the posterior portion is slightly canaliculate, a feature which already begins on the penultimate whorl, the profile line is represented by an obtuse angle having a short, concave posterior, and a long straight posterior side. The revolving lines noticed on the spire whorls have almost disappeared, only one or two lines remaining, though they are rather indistinct; on the other hand the striæ of growth become stronger; near the aperture the surface is still covered with a brown shiny epidermis and the striæ of growth become very numerous and closely set. Towards the anterior end a number of weak, revolving keels, separated by rather broad interstices, are visible.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Meiocardia metavulgaris*, Singu.
Zone of *Arca theobaldi*, Kama.
Zone of *Parallelipipedum prototortuosum*, Kama.
Zone of *Pholas orientalis*, Thayetmyo.
Zone of *Aricia humerosa*, Thayetmayo.
Zone of *Cytherea erycina*, Prome.

Remarks.—*Conus avaënsis* is so similar to *Conus malaccanus* that at the first glance both species might be considered the same; on closer examination it will, however, be seen that they are decidedly different: *Conus avaënsis* has a higher spire and cos. $\frac{1}{2}$ = ·51 is considerably larger than that of *Conus malaccanus* which is ·44 to 42; the step-like spire as well as its concave profile line form another distinctive feature of *Conus malaccanus;* in *Conus avaënsis* the profile line is S-shaped, and each whorl comes close up to the keel of its predecessor.

I have not been able to find any living relative of this species, though I cannot state with certainty that there exists none, but it seems that there is a certain similarity with *Conus diversiformis*, Desh., from the Eocene of Paris.

CONUS YULEIANUS, spec. nov., Pl. XXIII, figs. 21, 22.

MEASUREMENTS.

Height	25 mm. (approx.).
Width	12·5 „
Apical angle	90°
Angle of body whorl	35°

The shell is of small size, double conical in shape consisting of an elevated turreted spire and a large accuminate body whorl.

Embryonic whorls not observed.

The spire consists of about seven flat whorls, separated by a sharp suture; the surface of the whorls forms a steep angle with the suture which becomes only slightly flatter on the later ones; the profile line is slightly curved but sharply step-like because each succeeding whorl does not reach up to the keel of the preceding one. The surface is covered with numerous exceedingly fine revolving lines.

The body whorl is high, broad at the posterior, accuminate at the anterior end, divided by a sharp keel into a small posterior part, gently sloping towards the suture and a long anterior one, sloping in opposite direction. The profile line of the body whorl forms, therefore, an obtuse angle having two straight sides, a shorter posterior and a larger anterior one. Surface perfectly smooth except for numerous striæ of growth; there appear, however, a few indistinct spiral lines on the anterior end.

Aperture narrow, anteriorly apparently not expanded.

Geological occurrence.—

Zone of *Aricia humerosa*, Thayetmyo.
Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—I hesitated for a long time before I distinguished this species under a separate name, but on examining and comparing its features with those of the other species here described, I found that it would be impossible to unite it with any one of them. In shape *Conus yuleianus* is almost the same as *Conus hanza* except that the spire is certainly a little lower, the difference in the apical angle being about 10°; a more distinctive feature is, however, the ornamentation of the body whorl which is covered with engraved lines in *Conus hanza*, while it is perfectly smooth except for a few spiral lines on the anterior end in *Conus yuleianus*. On the other hand, it bears by the latter character a great similarity to *Conus malaccanus*, but the spire of this species is much lower and the apical angle larger than in *Conus yuleianus;* the spire of this species is also much less step-like than in *Conus malaccanus.*

From *Conus avaënsis* it differs by a higher spire, composed of step-like whorls, covered with much finer revolving striæ.

The specimen is too ill-preserved to allow of a comparison with either living or fossil species.

CONUS HANZA, spec. nov., Pl. XXIII, figs. 23, 24, 24*a*.

MEASUREMENTS.

	I	II
Height . . .	27 mm. (approx.).	9 mm.
Width . . .	14 „	4·5 „
Apical angle . . .	80°	78°
Angle of body whorl .	28° (?)	40°

The shell is of small size only, double conical in shape consisting of a high elevated spire and a large attenuated body whorl.

There are three to four rounded and smooth embryonic whorls, which formed a high spire during the brephic stage.

The spire is composed of about six whorls, separated by a sharp suture; the surface of the whorls is steeply inclined towards the suture in the earlier whorls, but becomes flatter with advancing age; as each succeeding whorl does not reach up to the preceding one, the profile line of the spire is, though curved, distinctly step-like. The ornamentation consists of a few revolving lines.

The body whorl is large, broad at its posterior, accuminate at its anterior end; a sharp keel sets off a small posterior part which is slightly concave, sloping towards the suture, from a large anterior one sloping in opposite direction. The revolving lines have disappeared on the posterior part, and there are only striæ of growth a few of which are raised and sharper than the others, following at regular intervals, thus imitating longitudinal ribs. The whole length of the anterior part is covered with about 20, deeply engraved revolving lines, separated by broad and flat interstices.

Aperture not observed.

Geological occurrence.—

Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—Though the general shape of this species with its high turreted spire, raised on a broad basis is almost the same as that of *Conus yuleianus*, it differs from it, as well as from all the other species here described, by the ornamentation of the body whorl. In all the other species it is only provided, towards the anterior end, with a certain number of rounded spiral keels, separated by linear interstices; in *Conus hanza* the whole surface is covered with sharply engraved lines separated by flat broad interstices.

Conus tjaringinensis, K. Martin, exhibits a certain similarity with this species, though it seems certain that it is different.

Among the living species *Conus lacteus* and *Conus subulatus*, Kiener, exhibit a similar ornamentation of the body whorl, but both species show a much less elevated spire.

It is under these circumstances rather difficult to settle the relationship of *Conus hanza*; it seems certain that it has no relative in the Eocene of Paris, neither could I find a similar species among the fauna of the Indian Ocean, but it seems that *Conus sinensis*, Sow., is a near relative, a question which I could not decide having no specimens of that species for comparison. It is, therefore, probable that *Conus hanza* represents a type extinct among the present fauna of the Indian Ocean.

CONUS (LEPTOCONUS) PROTOFURVUS, spec. nov., Pl. XXIII, figs. 25, *a-b*, 26, *a-b*.

1895. *Conus (Leptoconus) marginatus*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 48, pl. X, figs. 8, 8*a*, 8*b*.

MEASUREMENTS.

Height . . .	25 mm. (approx.).
Width . . .	19·3 „
Apical angle . .	65°
Angle of body whorl .	26°

The shell is of small size, double conical in shape, being composed of a high elevated spire and a long accuminate body whorl.

Embryonic whorls not observed.

The high elevated spire consists of at least six whorls, separated by a deep suture; the surface of the whorls forms a steep angle with the suture, which does not seem to change much with advancing age; the profile line is therefore almost straight, but slightly step-like, because each succeeding whorl does not fully reach up to the preceding one.

The body whorl is high, rather narrow at its posterior end, accuminate in front. A sharp keel sets off a small posterior part which gently slopes towards the suture from a larger anterior one, sloping in opposite direction. About one-half to two-thirds of the surface is smooth; the anterior half or third is covered with deeply engraved revolving lines, separated by broad interstices which are almost raised into ribs near the anterior end. Striæ of growth numerous, but somewhat irregular.

Aperture long, very narrow, outer lip thin and sharp.

Geological occurrence.—

Zone of *Paracyathus caeruleus*, Yenangyat.

Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—The general shape of *Conus protofurvus* resembles greatly that of *Conus galensis*, from which it is easily distinguished by the characters of the spire; in *Conus galensis* the upper part of the whorls, *i.e.*, that which is visible of the spire, is deeply canaliculate; in *Conus protofurvus* it is perfectly flat so that all the whorls are almost flush with each other; though the spire is somewhat step-like it never attains that degree as observed in *Conus galensis*.

In my previous memoir I identified this species with *Conus margitatus*, Sowerby, but I think it better to distinguish it under a special name. *Conus margitatus* has apparently a lower spire, and its whorls are canaliculate and not plain as in *Conus protofurvus*.

There is no similar species described from either Java or Sumatra, nor could I find among the fauna of the Indian Ocean a species which could be compared to it. On the other hand, *Conus furvus*, Reeve, from the Philippine Islands exhibits the greatest similarity, the chief distinguishing feature being a larger size; but as I could not compare a specimen of that species I refrain from expressing any further opinion except that it is very probable that *Conus protofurvus* represents a type extinct among the fauna of the Indian Ocean.

CONUS GALENSIS, spec. nov., Pl. XXIII, fig. 27, *a-b*.

MEASUREMENTS.

Height . . .	20 mm. (approx.).
Width . . .	8 „
Apical angle . .	78°
Angle of body whorl .	18°

The shell is of small size, elongate and double conical in shape, composed of an elevated turreted spire and a high, accuminate body whorl.

Embryonic whorls not observed.

Only two and a half spire whorls are preserved, but they prove that the spire was elevated and composed of rather low whorls, which were deeply canaliculate on the upper side and set with fine granulations along the keel; as each succeeding whorl leaves free a considerable part of the preceding one, the step-like profile line of the spire is more pronounced than in any of the other species.

The body whorl is rather high, not very broad at its posterior end, accuminate anteriorly; a sharp keel divides a narrow, deeply canaliculate posterior portion, sloping towards the suture from a large anterior one, sloping in opposite direction. The profile line is therefore represented by a sharp angle having a short deeply concave posterior and a large apparently slightly concave anterior side.

The surface is smooth, but there appear a few indistinctly visible revolving lines on the posterior portion, while the anterior one bears about 6—7 deeply engraved lines separated by broad flat interstices.

Striæ of growth indistinct.

Aperture long, narrow, outer lip apparently thin and sharp.

Geological occurrence.—

Zone of ***Paracyathus caeruleus***, Yenangyat.

Remarks.—***Conus galensis*** bears the greatest similarity to ***Conus margaritatus***, Sow., but it is easily distinguished from that species by the deeply canaliculate whorls, and the strongly step-like profile line of the spire.

I remarked above that the anterior side of the profile line of the body whorl is slightly concave; having only one specimen under examination I am not quite sure whether this feature, which is just perceptible, is an original one or due to disfiguration by pressure.

I have not been able to trace any fossil or living relative of this species, which with the greatest probability represents an extinct type.

III. Order: OPISTHOBRANCHIA, Milne Edwards.

Family: *ACTÆONIDÆ*, Gray.

Genus: RINGICULA.

Ringicula turrita, K. Martin, Pl. XXIII, fig. 28, *a-c*.

1883—87. ***Ringicula turrita***, K. Martin, Tiefbohr. auf Java, Beitr. zur. Geol. Ost. Asiens und Australiens, 1st ser., Vol. III, p. 45, pl. IV, fig. 45.

Measurements.

Length	.	3 mm.
Width	.	2 „

The minute shell is oval in shape, rather globose and consists of a very short spire and a comparatively large and inflated body whorl.

There are three rounded spire whorls separated by a rather deep suture; it is not quite clear whether they are smooth, or covered with the same flat revolving ornamentation as the body whorl.

The body whorl is rather large occupying at least two-thirds of the total height, globose, slightly accuminate in front. The ornamentation consists of very fine rounded revolving keels which cover the whole of the surface and are separated by interstices of their own breadth.

The aperture is rather large, anteriorly broad, accuminate in posterior direction; the outer lip thick, reflected, inner lip callous, but well set off against the other part of the surface. There are two strong oblique collumellar plaits.

Geological occurrence.—

Zone of ***Parallelipipedum prototortuosum***, Kama.

Remarks.—Only a single specimen which is not particularly well preserved has come under examination, but it agrees perfectly well with ***Ringicula turrita***, K. Martin, as regards shape, ornamentation, and character of the aperture.

IV.—ARTHROPODA.

Class: CRUSTACEA.

Order: CIRRIPEDIA.

Family: *BALANIDÆ*, Daw.

Genus: BALANUS LIST.

BALANUS TINTINNABULUM, Linné, Pl. XXIV, figs. 1, 2.

1853. *Balanus sublævis*, d'Arch., Descr. des Anim foss. du Groupe Num. de l'Inde, p. 341, pl. XXIV, fig. 15.
1879-80. „ *tintinnabulum*, Martin, Tertiärschichten auf Java, p. 131, pl. XXIII, figs. 3 and 4.
1883—87 „ „ Martin, Tiefbohr. auf Java, Beitr. zur Geolog. Ostasiens und Australiens, 1st ser., Vol. III, p. 40, pl. III, fig. 36.

This species is distinguished by fine pores which permeate the walls, and a cancellated basis.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Meiocardia metavulgaris*, Singu.
Zone of *Cancellaria martiniana*, Minbu.
Zone of *Paracyathus caeruleus*, Yenangyat.
Zone of *Arca theobaldi*, Kama.
Zone of *Parallelipipedum prototortuosum*, Kama.
Zone of *Aricia humerosa*, Thayetmyo.
Zone of *Cytherea erycina*, Prome.

Remarks.—I fully agree with Martin who thinks that Messrs. d'Archiac and Haime's *Balanus sublævis* is identical with *Balanus tintinnabulum*, Lin. On the other hand, I think that the same applies to *Balanus sublævis*, Sow., a view which is perhaps not wrong, if we consider the varying shape the test of Balanus takes.

Order: DECAPODA.

Sub-order: MACRURA, Latr.

Family: *THALASSINIDÆ*, M. E.

Genus: CALLIANASSA, Leach.

CALLIANASSA BIRMANICA, spec. nov., Pl. XXIV, figs. 3, *a-b*, 4, *a-e*, 5, *a-d*.

Only fragments of both hands have come under examination which are, however, distinguished by a large size; the largest specimen measuring 31 mm. in height and slightly more than 31 mm. in length without including the immoveable finger.

The hand is, therefore, almost square in shape. The external side is tumid, the internal one flat, slightly concave at the base of the immoveable finger.

The external side is covered with numerous, fine granules which are rather unevenly distributed and separated by broad interstices; these granules become slightly stronger at the proximal end, and still more so towards the base of the fingers, where they attain the strength of big, rounded tubercules. At the base of the immoveable finger some of the strongest tubercles are arranged in a row, which apparently extends in anterior direction on its external side. Similar granules are on the internal side, but here they become stronger, more numerous and closely set towards the lower edge and the base of the immoveable finger. Lower edge finely serrated, upper edge only set with a few short spines at its posterior end. A strong pointed thorn on the lower edge of the base of the moveable finger. Pores apparently restricted to the lower posterior corner, none observed on either edge; neither moveable or immoveable finger preserved.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Meiocardia metavulgaris*, Singu.
Zone of *Cancellaria martiniana*, Minbu.
Zone of *Paracyathus caeruleus*, Yenangyat.
Zone of *Arca theobaldi*, Kama.
Zone of *Parallelipipedum prototortuosum*, Kama.

Remarks.—This species is so similar to *Callianassa dijki*, K. Martin, that I have for a long time hesitated to distinguish it under a new name. The shape of the hand and its ornamentation are so alike in both species that it appears difficult to discover any differences. After carefully considering all the characters I think *Callianassa birmanica* can be distinguished in the following way: the hand attains apparently a larger size and the granulation is much coarser; the chief distinctive feature is the absence of the pores along the lower edge, but the presence of an irregularly distributed number of them on the lower posterior corner of the internal side.

K. Martin states that *Callianassa dijki* bears the greatest similarity to *Callianassa maxima*, A. M. Edwards, from Siam. Unfortunately I have not been able to compare the paper quoted, the Arch. du Museum d'hist. nat. of Paris not being in the library of the Geological Department, but to judge from Martin's remarks, *Callianassa maxima*, M. E., must be closely related to, if not identical with, *Callianassa birmanica*.

Sub-order: BRACHYURA, Latr.

Family: *OXYSTOMATA*, Milne Edwards.

Genus: CALAPPA, Fabr.

CALAPPA PROTOPUSTULOSA, spec. nov., Pl. XXIV, fig. 6, *a-b*.

The carapace is subcircular in shape, its length 23·5 mm. being only slightly smaller than the breadth with 26·5 mm. The upper surface is strongly curved in

antero-posterior, more flatly in lateral direction. Antero-lateral and postero-lateral margin form almost a semicircle. The antero-lateral margin is set with fine compressed and elongate tubercles; those close to the orbital edge being slightly larger than the others; postero-lateral margin set with probably five short spines separated by rather broad intervals and apparently increasing in posterior direction. Posterior margins not observed but probably rather short.

Frontal lobe rather broad but unfortunately damaged; so it cannot be said whether it is bilobed or not, but it projected certainly beyond the level of the orbit. Supra-orbital margin tumid, the external angle apparently set with two short broad spines. The regions are, with the exception of the gastro-cardiac region which is delineated by two longitudinal furrows which increase in depth and breadth in posterior direction, not well marked.

The gastro-cardiac region forms a high, rather narrow rounded ridge, the anterior portion of which is set with a few flat tubercles of rather large size, while the posterior part is apparently smooth.

There is no differentiation between the hepatical and branchial regions; this part of the carapace bears two oblique rows of low rounded tubercles; the external row begins at the external orbital angle and terminates at the second thorn of the postero-lateral margin, the tubercles gradually increasing in size in posterior direction till about the middle, and then decreasing again. The internal row begins at the anterior end of the gastro-cardiac ridge and probably terminates at the corner of the postero-lateral and posterior margin. Its posterior part seems to form a low ridge instead of isolated tubercles.

The whole surface was probably covered with very fine closely set granulations.

Geological occurrence.—

From two different horizons of unknown position near Thayetmyo.

Remarks.—The whole characters of this species are so similar to *Calappa pustulosa*, Alcock, from the Indian Ocean, that it is almost difficult to discover any differences. The only differences which I can discover are the more regularly crenulated antero-lateral margin, and the smaller tubercles on the postero-lateral margin.

Genus: EBALIA, Leach.

EBALIA TUBERCULATA, spec. nov., Pl. XXIV, figs. 7, 7*a*.

The carapace is transversally ovate, its breadth 16 mm. being larger than its length 12 mm; the anterior, larger, part is semicircular, the posterior part is slightly smaller, contracted and truncate at the posterior margin.

The antero-lateral margin is curved, and apparently set with a few obsolete thorns; the junction with the postero-lateral margin marked by a short spine. The postero-lateral margin is straight and forms a very obtuse angle with the short posterior margin.

Front and orbits not observed.

The division of the regions obsolete, only the posterior part of the gastric and the cardiac region well set off from the branchial region, by deep longitudinal furrows.

These furrows begin on either side of the metagastric lobe and quickly gaining in depth, continue on either side of the cardiac region as far as the posterior margin. Gastric and cardiac region separated by a faint but distinct transversal furrow. The metagastric lobe bears a low tubercle, and a strong spine rises in the middle of the strongly convex cardiac region.

Hepatic and branchial regions amalgamated; a low tubercle on both the mesobranchial and metabranchial lobes.

Geological occurrence.—

Horizon unknown. Thayetmyo.

Remarks.—I have not been able to discover any living or fossil relative of this species.

Family : *CYCLOMETOPA*, Milne Edwards.

Genus : NEPTUNUS, de Hann.

NEPTUNUS, SPEC., Pl. XXIV, figs. 8, 8*a*, 9, 9*a*.

Two fragments of hands, a left and a right one, most probably belong to this genus. Both are smooth and the external side bears two longitudinal ridges, the lower of which terminates rather abruptly, the internal side bears a single median ridge directly opposite to the lower one of the external side, ending like this abruptly and probably in a short spine.

Geological occurrence.—

Unknown horizon. Thayetmyo.

Remarks.—The specimens are too fragmentary to allow of any comparison with either living species or those described by Stolizcka from Sind.

CANCER, SPEC., Pl. XXXIV, figs. 10, 10*a*.

1895. *Pagurus, spec.*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, p. 44.

Fragments of the hands and fingers of a large species are very common. The fingers are a little irregularly curved and set with numerous strong tubercles and thorns.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.

Zone of *Meiocardia metavulgaris*, Singu.

Several unknown horizons. Thayetmyo and Prome.

Remarks.—The specimens are too fragmentary to allow of an accurate determination, and I preferred to express my views in a less decided way than I did in my previous memoir, where I determined them as *Pagurus*, spec.

V.—PISCES.

1. Sub-class: SELACHII.

1. Order: PLAGIOSTOMI.

1. Sub-order: SQUALIDÆ.

Family: *LAMNIDÆ.*

Genus: OXYRHINA, Agassiz.

OXYRHINA PAGODA, spec. nov., Pl. XXV, figs. 1, *a-e*, 2, *a-e*, 3, *a-b*.

The teeth are of small size only, and distinguished by the peculiar termination of the crown, which assumes the shape of a broad arrow-head.

(*a*) *Median teeth.*—The largest tooth does not exceed 15·5 mm. in length, of which about two-thirds are formed by the crown. The root is rather low and apparently not deeply bifurcated, the lateral branches being therefore short. The internal surface is strongly convex, bearing a shallow incision for the insertion of the nerve in the centre; the external surface is flat.

The crown is elongate, slender, curved inwards at the base and again outwards at the upper end. The lateral edges which are rounded near the base taper slightly but expand quite suddenly, and then converge quickly towards the upper end. A sharp corner is thus produced, and from this point the lateral edges are sharp and cutting. Inner side of crown strongly convex near the base, but flattened towards the upper end; outer side flat.

(*b*) *Lateral teeth.*—The lateral teeth differ from the median teeth chiefly by a broader root, and by the lateral edges being sharp and cutting from base to top, but the crown is straight like that of the median teeth and not turned backwards.

Geological occurrence.—

Unknown horizon near Thayetmyo.

Remarks.—The curious arrow-head shape of the crown readily distinguishes this species.

OXYRHINA SPALLANZANII, Bonaparte, Pl. XXV, figs. 4, 5, *a-e*, 6. *a-e*.

The teeth are of small size not exceeding 17 mm. in length, slender and lanceolate in shape; crown much higher than root.

(*a*) *Median teeth*.—The median teeth are distinguished by a narrow, deeply bifurcated root and the lateral edges of the crown being sharp only for the upper two thirds and rounded at the basal part. The root is rather thick, externally flat, even concave, internally strongly convex, bearing a deep longitudinal incision for the insertion of the nerve. Its lower part is sloping, the lower edge concave, the lateral branches short. The crown is elongate, slender and lanceolate, slightly curved inwards at the base and outwards at the upper end, the lateral edges are sharp and cutting for the upper two-thirds, but rounded near the base. The internal surface is convex, the outer one is flat. Cross section near the base almost circular.

(*b*) *Lateral teeth*.—The lateral teeth are characterised by a broad bifurcated root, while the edges of the crown are sharp and cutting from the base to the top. The root is rather low, but broad, forming two long lateral branches which are flat on the external, strongly convex on the internal side. The crown has the same shape as that of the median teeth, being straight and not turned in posterior direction, but the lateral edges are sharp and cutting from top to base, and the cross section at the base is elliptical.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Cancellaria martiniana*, Minbu.
Zone of *Paracyathus caeruleus*, Yenangyat.

Remarks.—This species is easily distinguished from *Oxyrhina pagoda*, spec. nov., by the absence of the arrow-head like expansion of the upper end.

Genus: ALOPIAS, Rafinesque.

ALOPIAS VULPES, Gmelin, Pl. XXV, fig. 7, *a-c*.

Two teeth only have come under examination, both being probably from the lateral part of the jaw; the largest measures 9·5 mm., the other one about 3 mm. in height. The root is very low but broad and hardly cut out at the lower edge; its external side is flat, the internal one strongly convex and sloping at its lower part, bearing a deep incision for the nerve in the middle.

The crown is rather compressed, obliquely triangular, the top being strongly turned in posterior direction. The edges are sharp and cutting for the whole of their length; the anterior one is slightly concave at the base and very oblique; the posterior one indented near the base; the upper part being straight and almost vertical, the lower part curved and horizontal. Internal and external surface strongly convex.

Geological occurrence.—

Unknown horizon near Thayetmyo.

Remarks.—There seems to be no doubt that the tooth here described is identical with the teeth as observed in the living *Alopias vulpes*, Gmel.

Genus: CARCHARODON, Smith.

CARCHARODON MEGALODON, Agassiz, Pl. XXV, figs. 8, 8*a*.

1883—87. *Carcharodon megalodon*, K. Martin, Tiefbohr. auf Java, Beitr. zur Geolog. Ost. Asiens und Australiens, 1st ser., Vol. II, p. 23, pl. I, fig. 12.

A single lateral tooth only has come under examination, its length is 46 mm. and its greatest breadth about 40 mm. The internal side is flat, the outer convex but distinctly flattened in the middle.

The root is broad, but low and strongly compressed, its lower edge so slightly curved that the lateral branches are very short. No hole for the insertion of the main nerve.

The crown is broadly triangular, just slightly curved backwards. Edges sharply serrated, no secondary lateral teeth.

Geological occurrence.—

Unknown horizon near Prome.

Remarks.—The single tooth which I examined agrees so well with *Carcharodon megalodon* as figured by K. Martin that there can be no doubt as to the identity, but whether this species is really identical with *Carcharodon megalodon*, Agass., as Martin believes, remains to be seen.

Family: *CARCHARIDÆ.*

Genus: HEMIPRISTIS, Agassiz.

HEMIPRISTIS SERRA, Agassiz, Pl. XXV, figs. 9, *a-e*, 10.

(*a*) *Median teeth.*—A single median tooth probably from the lower jaw measures 19 mm. in length and 10 mm. in breadth; it is lanceolate in shape; and the crown is much higher than the root. The root is comparatively short and deeply bifurcate; the external side is flat, the internal side rising in the middle in the shape of a high cone which bears a deep longitudinal notch for the insertion of the nerve.

The crown is rather thick at the base, but strongly tapering towards the top. The internal side is convex, the external side flat. Both edges are set with sharp short serrations which begin as very small ones at the base but increase in length towards the top, stopping suddenly a short distance from it, so that the last portions of the edges are smooth and not serrated.

(*b*) *Lateral teeth.*—A lateral tooth deprived of its root is still imbedded in the matrix, therefore its characters can only be partly recognized; it seems that the crown was rather compressed, and its top turned strongly backwards; the anterior edge is convex and set with fine serrations, gradually increasing towards the top; the posterior edge is concave and the serrations much stronger than on the anterior side, increasing also in size from base to top. The lastportion of the edges is free from serrations and smooth.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.
Zone of *Paracyathus caeruleus*, Yenangyat.
Unknown horizon near Thayetmyo

Genus: CARCHARIAS, Cuvier.

CARCHARIAS (PRIONODON) GANGETICUS, Müller and Henle, Pt. XXV, figs. 11, *a-e*, 12, *a-b*, 13, *a-b*, 14, *a-b*, 15, *a-b*.

1895. *Carcharias (Prionodon), spec.*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, pt. I, p. 45.

The teeth are of small size only, none exceeding 14 mm. in length and strongly compressed. The crown exhibits a varying triangular shape, the root is always low and hardly bifurcated.

(*a*) *Median teeth.*—In the median teeth the crown takes the shape of an equilateral triangle, with rather a broad basis and sides which are deeply concave near the base and afterwards straight. The external surface is flat, the internal slightly concave. The edges are very finely serrated. The root is short, but broad, internally convex, exhibiting a deep incision for the insertion of the nerve, externally flat, and hardly bifurcated.

(*b*) *Lateral teeth.*—In the lateral teeth the crown takes the shape of an oblique triangle, the point of which is more or less turned backwards; the anterior edge, therefore, being the longer, the posterior the shorter one. The serrations appear to be slightly stronger than in the median teeth.

Geological occurrence.—

Zone of *Mytilus nicobaricus*, Singu.
Zone of *Meiocardia metavulgaris*, Singu.
Zone of *Cancellaria martiniana*, Minbu.
Zone of *Paracyathus caeruleus*, Yenangyat.
Zone of *Anoplotherium birmanicum*, Yenangyoung.
Unknown horizon near Thayetmyo and Prome.

Remarks.—Though I have not been able to study the teeth of *Carcharias* (*Prionodon*) *gangeticus* in detail I have not the slightest doubt that the specimens here described are identical with it as they seem to agree so far as I have been able to ascertain.

Genus: GALEOCERDO, Müller and Henle.

GALEOCERDO, SPEC., Pl. XXV, fig. 16.

1895. *Galeocerdo spec.*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, pt. 1, p. 44.

Two fragments of teeth represent unquestionably this genus, but they are too ill-preserved to allow of a specific determination.

The crown is triangular in shape, the point strongly turned backwards; anterior edge convex, set with very fine serrations, posterior edge indented, the larger upper portion set with fine serrations, the smaller lower one bearing two or perhaps three smaller denticulations, the edges of which are serrated.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.

2. Sub-order: BATOIDEI.

Family: *MYLIOBATIDÆ*, Meeradler.

Genus: MYLIOBATES, Cuvier.

MYLIOBATES, SPEC., Pl. XXV, figs. 17, 18, *a-b*.

1895. *Myliobates spec.*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, pt. I, p. 45.

Fragments of the spine do not seem to be unfrequent, but it is impossible to say whether they belong to one and the same species or not. A fragment measuring about 27 mm. in length appears to differ from another smaller specimen in the shape of the serrations with which the lateral edges are set; in this particular specimen they are rather long and so strongly curved backwards that they almost seem to lie flat upon each other. In the smaller specimen they are rather short, spinous and well separated from each other. In both specimens the section is elliptical.

There is, however, a third specimen which considerably differs by its section from the former two and may probably represent a distinct species. The upper side is strongly convex, the lower side flattened angular and narrower than the former one. The lateral serrations are apparently short and strongly curved backwards.

Geological occurrence.—

Zone of *Cancellaria martiniana*, Minbu.
Zone of *Anoplotherium birmanicum*, Yenangyoung.
Unknown horizon near Thayetmyo.

2. Sub-class: TELEOSTEI.

OTOLITHUS, SPEC., Pl. XXV, figs. 19, 19*a*.

1895. *Otolithus spec.*, Noetling, Miocene Foss. Upper Burma, Mem. Geolog. Survey of India, 1895, Vol. XXVII, pt. 1, p. 45.

The few specimens which have come under examination seem all to belong to one and the same species. They do not exhibit any particular distinguishing features, and are apparently not represented among those described by Koken.[1]

Geological occurrence.—

Zone of *Paracyathus caeruleus*, Yenangyat.

[1] Zeitschrift d. Deutsch. Geolog. Gesellschaft, 1884, Vol. XXXVI, p. 500.

SILUROIDARUM, Gen., Pl. XXV, figs. 20, 20*a*.

A fragment of a spine which probably belonged to the pectoral fin of a siluroid agrees very well with a similar fragment described by Mr. Lydekker from the Siwaliks.

Geological occurrence.—

Zone of ***Anoplotherium birmanicum***, Yenanyoung.

V.—REPTILIA.

Order: LEPIDOSAURIA.

Sub-order: OPHIDIA.

Family: *PYTHONIDÆ.*

Genus: PYTHON, Daudin.

PYTHON CF. MOLURUS, Linné, Pl. XXV, figs. 21, 21*a*.

1886. *Python molurus*, Lydekker, Ind. Ter. and Postter. Vertebrata, Vol. III, pts. 7 and 8, pp. [illegible]-257, pl. XXXV, figs. 3-7.

A single specimen of a vertebra corresponds very well with Lydekker's figs. 6 and 7, pl. XXXV, and should therefore belong to the anterior part of the caudal region.

Geological occurrence.—

Zone of ***Anoplotherium birmanicum***, Yenangyoung.

Order: CROCODILIA.

Sub-order: EUSUCHIA.

1. Family: *GAVIALIDÆ.*

Genus: GHARIALIS, Gmelin.

GHARIALIS GANGETICUS, Gmelin, Pl. XXV, fig. 23, *a-b*.

A single small tooth measuring 19 mm. in length has come under examination; it is elongately conical in shape, slightly curved inwards, having a circular section of 5 mm. diameter at the base; the whole surface is covered with longitudinal keels, converging towards the top, two of which in the middle of the anterior and posterior side being much stronger than the others.

Geological occurrence.—

Zone of ***Anoplotherium birmanicum***, Yenangyoung.

Remarks.—It is unquestionable that this tooth is identical in all its features with teeth from the living *Gharialis gangeticus*, Gmelin.

2. Family: *CROCODILIDÆ.*

Genus: CROCODILUS, Laurill.

CROCODILUS PALUSTRIS, Lesson, Pl. XXV, fig. 22, *a-b*.

Two fragments of teeth have come under examination, the larger one measuring 12 mm. in height. The fragment represents unquestionably the upper end of a tooth of elliptical section, the antero-posterior diameter of which measures 11·5 mm. and the other one 8 mm. It is conical in shape, rounded at the top, anterior and posterior side with a sharp keel. Enamel smooth, except near the top where it becomes finely wrinkled.

Geological occurrence.—

Zone of ***Anoplotherium birmanicum***, Yenangyoung.

Remarks.—Having compared this fragment with teeth of the living ***Crocodilus palustris*** it seems certain to me that, notwithstanding its fragmentary state, there can be no doubt as to its identity.

VI.—MAMMALIA.

Sub-class: PLACENTALIA.

Order: UNGULATA.

Sub-order: ARTIODACTYLA.

Family: *ANTHRACOTHERIDÆ.*

Genus: ANOPLOTHERIUM.

ANOPLOTHERIUM BIRMANICUM, spec. nov., Pl. XXV, figs. 24, 24*a*, 25, 25*a*.

The larger molar may probably represent the third molar of the lower jaw, while the smaller one represents a more anterior one. So far it seems to me that in its character it does not agree with any of the described species.

Geological occurrence.—

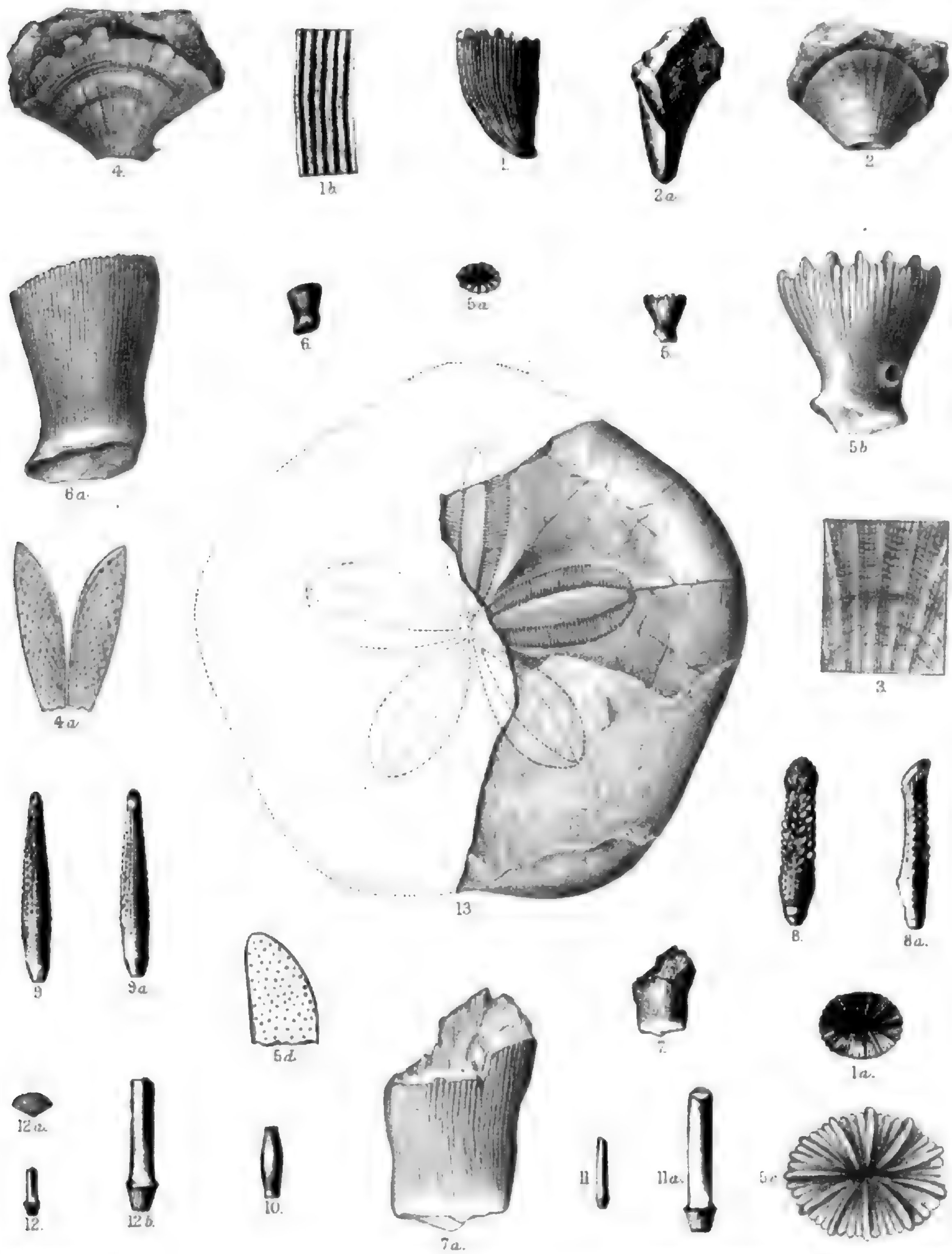
Zone of ***Anoplotherium birmanicum***, Yenangyoung.

PLATE I.

Fig. 1. CERATOTROCHUS ALCOCKI, spec. nov., nat. size. Zone of *Parallelepipedum prototortuosum*, Kama, page 100.
" 1*a*. " " " " Calice.
" 1*b*. " " " " part of outer wall, enlarged.
Fig. 2. FLABELLUM DISTINCTUM, Milne-Edwards, nat. size. Zone of *Pholas orientalis*, Thayetmyo, page 101.
" 2*a*. " " " "
Fig. 3. FLABELLUM DISTINCTUM, Milne Edwards, part of wall, enlarged. Zone of *Pholas orientalis*, Thayetmyo, page 101.
Fig. 4. FLABELLUM DISTINCTUM, Milne Edwards, nat. size. Zone of *Pholas orientalis*, Thayetmyo, page 101.
" 4*a*. " " " impression of septum, enlarged.
Fig. 5. PARACYATHUS CAERULEUS, Duncan, nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 102.
" 5*a*. " " " " Calice.
" 5*b*. " " " enlarged.
" 5*c*. " " " Calice, enlarged.
" 5*d*. " " " part of septum, enlarged.
Fig. 6. PARACYATHUS CAERULEUS, Duncan, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 102.
" 6*a*. " " " enlarged.
Fig. 7. EUPSAMMIA REGALIS, Alcock, nat size. Zone of *Paracyathus caeruleus*, Yenangyat, page 103.
" 7*a*. " " " enlarged.
Fig. 8. CIDARIS, spec. 1, nat. size. Zone of *Arca theobaldi*, Kama, page 104.
" 8*a*. " " "
Fig. 9. CIDARIS, spec. 1, nat. size. Zone of *Arca theobaldi*, Kama, page 104.
" 9*a*. " " "
Fig. 10. CIDARIS, spec. 1, nat. size. Zone of *Arca theobaldi*, Kama, page 104.
Fig. 11. CIDARIS, spec. 2, nat. size. Zone of *Arca theobaldi*, Kama, page 105.
" 11*a*. " " enlarged.
Fig. 12. CIDARIS, spec. 2, nat. size. Zone of *Arca theobaldi*, Kama, page 105.
" 12*a*. " " cross section.
" 12*b*. " " enlarged.
Fig. 13. CLYPEASTER DUNCANIANUS, spec. nov. Miocene, Prome, page 105.

GEOLOGICAL SURVEY OF INDIA.

Dr. Noetling. Palæontologia Indica: Memoir No. 3 Pl. 1.



K.D. Chandra. del.

Photogravure. Survey of India Offices Calcutta. January 1900.

PLATE II.

Fig. 1.	Ostrea peguensis, spec. nov.	Left valve, internal view, nat. size.	Thayetmyo, page 107.
„ 1a.	„ „ „	„ external view.	
Fig. 2.	Ostrea peguensis, spec. nov.	Right valve, external view, nat. size.	Thayetmyo, page 107.
„ 2a.	„ „ „	Left valve „ „	
„ 2b	„ „ „	Dorsal view.	
Fig. 3.	Ostrea promensis, spec. nov.	Right valve, external view, nat. size.	Thayetmyo, page 109.
„ 3a.	„ „ „	Left valve „ „	
„ 3b.	„ „ „	Dorsal view.	

GEOLOGICAL SURVEY OF INDIA.

Dr Noetling

Palæontologia Indica Memoir N°3 Pl II

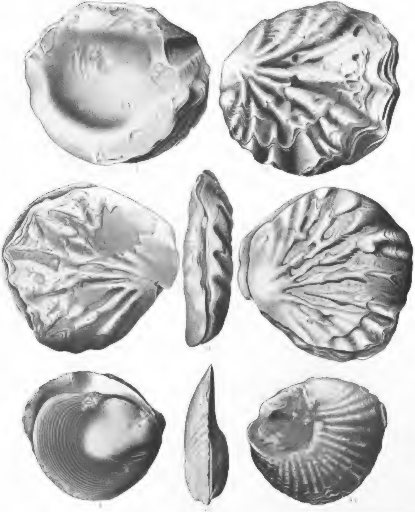


PLATE III.

Fig. 1. Ostrea promensis, spec. nov. Group of shells showing right valve, nat. size. Thayetmyo, page 109.

" 1a. " " " " " " left valve.

" 1b. " " " " " " dorsal view.

Fig. 2. Ostrea promensis, spec. nov. Right valve, nat. size. Thayetmyo, page 109.

" 2a. " " " Left valve.

" 2b. " " " Dorsal view.

Fig. 3. Ostrea papyracea, spec. nov. Right valve, external view, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 111.

" 3a. " " " " internal view.

" 3b. " " " " dorsal view.

Fig. 4. Ostrea papyracea, spec. nov. Right valve, external view, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 111.

" 4a. " " " " internal view.

" 4b. " " " " dorsal view.

Fig. 5. Ostrea papyracea, spec. nov. Left valve, external view, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 111.

" 5a. " " " " internal view.

" 5b. " " " " dorsal view.

Fig. 6. Ostrea papyracea, spec. nov. Left valve, external view, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 111.

" 6a. " " " " internal view.

" 6b. " " " " ventral view.

Fig. 7. Ostrea papyracea, spec. nov. Left valve, external view, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 111.

" 7a. " " " " internal view.

" 7b. " " " " posterior view.

Fig. 8. Lima griesbachiana, spec. nov. Right valve, nat. size. Zone of *Aricia humerosa*, Thayetmyo, page 113.

Fig. 9. Lima griesbachiana, spec. nov. Right valve, nat. size. Zone of *Aricia humerosa*, Thayetmyo, page 113.

" 9a. " " " " enlarged.

" 9b. " " " " dorsal view, nat. size.

" 9c. " " " " part of surface, enlarged.

Fig. 10. Lima protosquamosa, spec. nov. Right valve, nat. size. Zone of *Mytilus nicobaricus*, Singu, page 114.

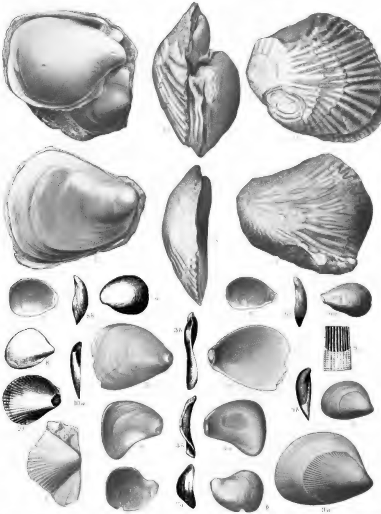
" 10a. " " " " ventral view.

Fig. 11 Pecten protosenatorius, spec. nov. Right valve, nat. size. Umbonal region Thayetmyo, page 115.

GEOLOGICAL SURVEY OF INDIA.

Dr Noetling

Palæontologia Indica. Memoir No 3 Pl. III.



Photogravure, Survey of India Offices, Calcutta, January 1901.

PLATE IV.

Fig. 1. PECTEN PROTOSENATORIUS, spec. nov. Right valve, nat. size. Thayetmyo, page 115.
" 1a. " " " Left valve.
" 1b. " " " Part of surface of right valve, enlarged.
Fig. 2. PECTEN KOKENIANUS, spec. nov. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 117.
" 2a. " " " " ventral view.
Fig. 3. PECTEN KOKENIANUS, spec. nov. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 117.
" 3a. " " " " ventral view.
" 3b. " " " " Umbonal part, external view, enlarged.
" 3c. " " " " " internal view, enlarged.
Fig. 4. PECTEN KOKENIANUS, spec. nov. Left valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 117.
" 4a. " " " ventral view.
Fig. 5. PECTEN KOKENIANUS, spec. nov. Left valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 117.
" 5a. " " " " ventral view.
" 5b. " " " " Umbonal part, external view, enlarged.
" 5c. " " " " " internal view, enlarged.
Fig. 6. PECTEN KOKENIANUS, spec. nov. Ornamentation of shell, strongly enlarged, page 117.
" 6a. " " " Transverse section of ribs.
Fig. 7. PECTEN IRRAVADICUS, spec. nov. Right valve, nat. size. Zone of *Meiocardia metavulgaris*, Singu, page 121.
Fig. 8. PECTEN IRRAVADICUS, spec. nov. Right valve, nat. size. Thayetmyo, page 121.
Fig. 9. AVICULA SUESSIANA, spec. nov. Right valve, nat. size. Zone of *Meiocardia metavulgaris*, Singu, page 122.
" 9a. " " " " ventral view.
Fig. 10. AVICULA SUESSIANA, spec. nov. Left valve, nat. size. Zone of *Meiocardia metavulgaris*, Singu, page 122.
" 10a. " " " " ventral view.
Fig. 11. AVICULA SUESSIANA, spec. nov. Cast of left valve, strongly enlarged. Zone of *Meiocardia metavulgaris*, Singu, page 122.
Fig. 12. VULSELLA LINGUA-TIGRIS, spec. nov. Zone of *Mytilus nicobaricus*, Singu, page 124.
Fig. 13. VULSELLA LINGUA-TIGRIS, spec. nov. Zone of *Mytilus nicobaricus*, Singu, page 124.
Fig. 14. VULSELLA LINGUA-TIGRIS, spec. nov. Zone of *Parallelipipedum prototortuosum*, Singu, page 124.
Fig. 15. MYTILUS NICOBARICUS, Reeve. Right valve, nat. size. Zone of *Mytilus nicobaricus*, Singu, page 125.
" 15a. " " " " " Ventral view.
Fig. 16. MYTILUS NICOBARICUS, Reeve. Left valve, nat. size. Zone of *Mytilus nicobaricus*, Singu, page 125.
Fig. 17. MYTILUS NICOBARICUS, Reeve. Left valve, nat. size. Zone of *Mytilus nicobaricus*, Singu, page 125.
" 17a. " " " " " Ventral view.
Fig. 18. MODIOLA BUDDHAICA, spec. nov. Right valve, nat. size. Zone of *Mytilus nicobaricus*, Singu, page 127.
" 18a. " " " " ventral view.

GEOLOGICAL SURVEY OF INDIA.

Dr. Noetling

Palæontologia Indica. Memoir No. 3 Pl. IV

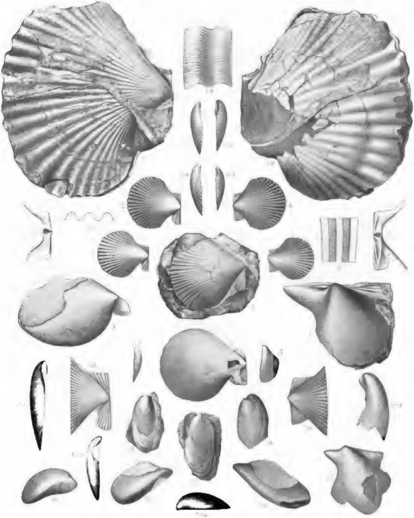


PLATE V.

Fig. 1. MYTILUS NICOBARICUS, Reeve. Left valve, strongly enlarged, page 125.
„ 1a. „ „ „ „ ventral view.
Fig. 2. MODIOLA BUDDHAICA, spec. nov. Right valve, nat. size. Zone of *Mytilus nicobaricus*, Singu, page 127.
„ 2a. „ „ „ Ventral view.
„ 2b. „ „ „ Dorsal view.
Fig. 3. MODIOLA PSEUDOBUDDHAICA, spec. nov. Left valve, nat. size. Zone of *Mytilus nicobaricus*, Singu, page 128.
„ 3a. „ „ „ „ ventral view.
Fig. 4. LITHODOMUS, spec., nat. size. Zone of *Meiocardia metavulgaris*, Singu, page 129.
„ 4a. „ „ „
„ 4b. „ „ „
Fig. 5. LITHODOMUS, spec., nat. size. Zone of *Meiocardia metavulgaris*, Singu, page 129.
Fig. 6. ARCA BURNESI, d'Archiac and Haime, var. media. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 131.
„ 6a. „ „ „ „ Left valve.
„ 6b. „ „ „ „ Anterior view.
„ 6c. „ „ „ „ Posterior view.
„ 6d. „ „ „ „ Dorsal view.
„ 6e. „ „ „ „ Right valve, enlarged.
„ 6f. „ „ „ „ Left valve, enlarged.
Fig. 7. ARCA BURNESI, d'Archiac and Haime, var. rotuntada. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 131.
„ 7a. „ „ „ „ Right valve, internal view.
„ 7b. „ „ „ „ Right valve, anterior view.
„ 8. ARCA BURNESI, d'Archiac and Haime, var. media. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 131.
Fig. 8a. „ „ „ „ Right valve, internal view.
„ 8b. „ „ „ „ Right valve, anterior view.
Fig. 9. ARCA BURNESI, d'Archiac and Haime, var. elongata. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 131.
„ 9a. „ „ „ „ Right valve, internal view.
„ 9b. „ „ „ „ Right valve, anterior view.
Fig. 10. ARCA BURNESI, d'Archiac and Haime, var. media. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 131.
„ 10a. „ „ „ „ Right valve, internal view.
„ 10b. „ „ „ „ „ anterior view.
„ 10c. „ „ „ „ „ internal view, enlarged.
„ 10d. „ „ „ „ „ dorsal view, enlarged.
Fig. 11. ARCA THEOBALDI, spec. nov., var. rotunda. Right valve, nat. size. Zone of *Arca theobaldi*, Kama, page 135.
„ 11a. „ „ „ „ Left valve.
„ 11b. „ „ „ „ Anterior view.
„ 11c. „ „ „ „ Posterior view.

PLATE V—*contd.*

Fig. 11*d*.	ARCA THEOBALDI, spec. nov., var. rotunda.	Dorsal view.
" 11*e*.	" " " "	Right valve, enlarged.
" 11*f*.	" " " "	Left valve, enlarged.
" 11*g*.	" " " "	Ribs of right valve, enlarged.
" 11*h*.	" " " "	Ribs of left valve, enlarged.
Fig. 12.	ARCA THEOBALDI, spec. nov., var. rotunda.	Right valve, nat. size. Zone of *Arca theobaldi*, Kama, page 135.
" 12*a*.	" " " "	" internal view.
" 12*b*.	" " " "	" anterior view.
Fig. 13.	ARCA THEOBALDI, spec. nov., var. media.	Right valve, nat. size. Zone of *Arca theobaldi*, Kama, page 135.
" 13*a*.	" " " "	" internal view.
" 13*b*.	" " " "	" anterior view.
Fig. 14.	ARCA THEOBALDI, spec. nov., var. elongata.	Right valve, nat. size. Zone of *Arca theobaldi*, Kama, page 135.
" 14*a*.	" " " "	" internal view.
" 14*b*.	" " " "	" anterior view.

GEOLOGICAL SURVEY OF INDIA.

Dr. Noetling — Palæontologia Indica: Memoir No. 3 Pl. V.

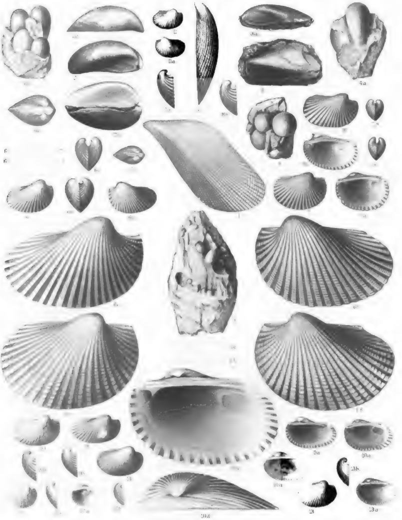


PLATE VI.

Fig. 1. ARCA THEOBALDI, spec. nov., var. media. Left valve, nat. size. Zone of *Arca theobaldi*, Kama, page 135.

„ 1a. „ „ „ „ „ internal view.

„ 1b. „ „ „ „ „ anterior view.

„ 1c. „ „ „ „ „ internal view, enlarged.

Fig. 2. ARCA THAYETENSIS, spec. nov. Left valve, nat. size. Thayetmyo, page 138.

„ 2a. „ „ „ „ anterior view.

„ 2b. „ „ „ „ portion of surface, enlarged.

„ 2c. „ „ „ „ cross section of ribs, enlarged.

Fig. 3. ARCA OLDHAMIANA, spec. nov. Left valve, nat. size. Thayetmyo, page 143.

„ 3a. „ „ „ „ portion of surface, enlarged.

„ 3b. „ „ „ „ cross section of ribs, enlarged.

Fig. 4. ARCA YAWENSIS, spec. nov. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 144.

„ 4a. „ „ „ „ „ Internal view.

„ 4b. „ „ „ „ „ Anterior view.

„ 4c. „ „ „ „ „ Dorsal view.

„ 4d. „ „ „ „ external view, enlarged.

„ 4e. „ „ „ „ cross section of ribs, enlarged.

Fig. 5. ARCA YAWENSIS, spec. nov. Left valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 144.

„ 5a. „ „ „ „ „ Internal view.

„ 5b. „ „ „ „ „ Anterior view.

„ 5c. „ „ „ „ „ Dorsal view.

„ 5d. „ „ „ „ „ Enlarged.

„ 5e. „ „ „ „ „ Cross section of ribs, enlarged.

Fig. 6. ARCA YAWENSIS, spec. nov. Right valve, internal view, enlarged. Zone of *Parallelipipedum prototortuosum*, Kama, page 144.

Fig. 7. ARCA MYOÏNSIS, spec. nov. Right valve, nat. size. Zone of *Arca theobaldi*, Kama, page 145.

„ 7a. „ „ „ „ „ Internal view.

„ 7b. „ „ „ „ „ Anterior view.

„ 7c. „ „ „ „ „ Dorsal view.

Fig. 8. ARCA MYOÏNSIS, spec. nov. Left valve, nat. size. Zone of *Arca theobaldi*, Kama, page 145.

„ 8a. „ „ „ „ „ Internal view.

„ 8b. „ „ „ „ „ Anterior view.

„ 8c. „ „ „ „ „ Dorsal view.

Fig. 9. ARCA MYOÏNSIS, spec. nov. Right valve, nat. size. Zone of *Arca theobaldi*, Kama, page 145.

„ 9a. „ „ „ „ „ Internal view.

„ 9b. „ „ „ „ „ Anterior view.

„ 9c. „ „ „ „ „ Dorsal view.

PLATE VI—*concld.*

Fig. 10. ARCA MYOËNSIS, spec. nov. Left valve, nat. size. Zone of *Arca theobaldi*, Kama, page 145.

„ 10*a*. „ „ „ „ „ Internal view.

„ 10*b*. „ „ „ „ „ Anterior view.

„ 10*c*. „ „ „ „ „ Dorsal view.

„ 10*d*. „ „ „ „ external view, enlarged.

„ 10*e*. „ „ „ „ cross section of ribs, enlarged.

„ 10*f*. „ „ „ „ dorsal view, enlarged.

Fig. 11. ARCA MYOËNSIS, spec. nov. Right valve, enlarged. Zone of *Arca theobaldi*, Kama, page 145.

„ 11*a*. „ „ „ „ cross section of ribs, enlarged.

Fig. 12. ARCA MYOËNSIS, spec. nov. Left valve, internal view, enlarged. Zone of *Arca theobaldi*, Kama, page 145.

Fig. 13. ARCA METABISTRIGATA, spec. nov. Right valve, nat. size. Zone of *Arca theobaldi*, Kama, page 139.

„ 13*a*. „ „ „ Left valve.

„ 13*b*. „ „ „ Right valve, internal view.

„ 13*c*. „ „ „ Left valve, internal view.

„ 13*d*. „ „ „ Anterior view.

„ 13*e*. „ „ „ Dorsal view.

„ 13*f*. „ „ „ Right valve, enlarged.

„ 13*g*. „ „ „ Left valve, enlarged.

„ 13*h*. „ „ „ Cross section of ribs of the anterior portion of the surface, enlarged.

„ 13*i*. „ „ „ „ „ of the posterior portion of the surface, enlarged.

Dr Noetling

Palæontologia Indica, Memoir N° 3 Pl VI

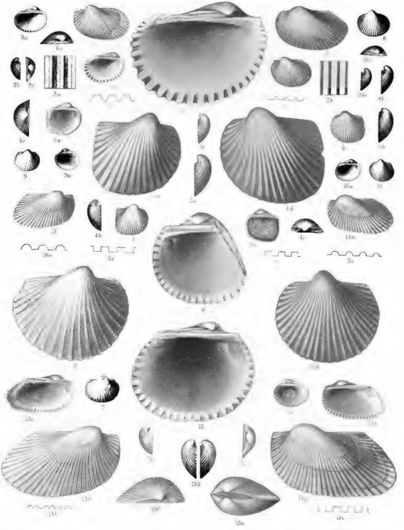


PLATE VII.

Fig. 1. Arca bistrigata, Dunker. Left valve, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 141.

,, 1*a*. ,, ,, ,, ,, enlarged.

Fig. 2. Arca bistrigata, Dunker. Left valve, enlarged and restored; the contour taken from a cast, the ornamentation from various other specimens, page 141.

,, 2*a*. Arca bistrigata, Dunker. Cross section of ribs, enlarged, page 141.

Fig. 3. Arca nannodes, K. Martin. Right valve, nat. size. Zone of *Arca theobaldi*, Kama, page 147.

,, 3*a*. ,, ,, ,, ,, ,, Internal view.
,, 3*b*. ,, ,, ,, ,, ,, Dorsal view.
,, 3*c*. ,, ,, ,, ,, ,, Anterior view.
,, 3*d*. ,, ,, ,, ,, Enlarged.
,, 3*e*. ,, ,, ,, ,, Internal view, enlarged.
,, 3*f*. ,, ,, ,, ,, Cross section of ribs, enlarged.

Fig. 4. Arca nannodes, K. Martin. Left valve, nat. size. Zone of *Arca theobaldi*, Kama, page 147.

,, 4*a*. ,, ,, ,, ,, ,, Internal view.
,, 4*b*. ,, ,, ,, ,, ,, Dorsal view.
,, 4*c*. ,, ,, ,, ,, ,, Anterior view.
,, 4*d*. ,, ,, ,, ,, Enlarged.
,, 4*e*. ,, ,, ,, ,, Cross section of ribs, enlarged.

Fig. 5. Arca bataviana, K. Martin, var. normalis. Right valve, nat. size. Zone of *Arca theobaldi*, Kama, page 148.

,, 5*a*. ,, ,, ,, ,, ,, ,, Internal view.
,, 5*b*. ,, ,, ,, ,, ,, ,, Anterior view.
,, 5*c*. ,, ,, ,, ,, ,, Enlarged.
,, 5*d*. ,, ,, ,, ,, ,, Internal view, enlarged.
,, 5*e*. ,, ,, ,, ,, ,, Dorsal view, enlarged.
,, 5*f*. ,, ,, ,, ,, ,, Cross section of ribs, enlarged.

Fig. 6. Arca bataviana, K. Martin, var. normalis. Left valve, nat. size. Zone of *Arca theobaldi*, Kama, page 148.

,, 6*a*. ,, ,, ,, ,, ,, ,, Internal view.
,, 6*b*. ,, ,, ,, ,, ,, ,, Anterior view.
,, 6*c*. ,, ,, ,, ,, ,, Enlarged.
,, 6*d*. ,, ,, ,, ,, ,, Dorsal view, enlarged.

Fig. 7. Arca bataviana, K. Martin, var. carinata. Right valve, nat. size. Zone of *Arca theobaldi*, Kama, page 148.

,, 7*a*. ,, ,, ,, ,, ,, ,, Anterior view.

Fig. 8. Arca bataviana, K. Martin, var. carinata. Left valve, nat. size. Zone of *Arca theobaldi*, Kama, page 148.

,, 8*a*. ,, ,, ,, ,, ,, ,, Anterior view.
,, 8*b*. ,, ,, ,, ,, ,, Enlarged.

PLATE VII—*concld.*

Fig. 9. ARCA PERTHENSIS, d'Archiac and Haime. Left valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 150.

„ 9a. „ „ „ „ „ Internal view.

„ 9b. „ „ „ „ „ Anterior view.

„ 9c. „ „ „ „ „ Dorsal view.

„ 9d. „ „ „ „ „ Part of surface, enlarged.

„ 9e. „ „ „ „ „ Cross section of ribs, enlarged.

Fig. 10. PARALLELIPIPEDUM PROTOTORTUOSUM, spec. nov. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 152.

„ 10a. „ „ „ Right valve nat. size. Internal view.

„ 10b. „ „ „ „ „ Dorsal view.

„ 10c. „ „ „ „ „ Anterior view.

„ 10d. „ „ „ „ „ Posterior view.

„ 10e. „ „ „ „ Enlarged.

„ 10f. „ „ „ „ Cross section of ribs, enlarged.

Fig. 11. PARALLELIPIPEDUM PROTOTORTUOSUM, spec. nov. Left valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 152.

„ 11a. „ „ „ Left valve, nat. size. Internal view.

„ 11b. „ „ „ „ „ Dorsal view.

„ 11c. „ „ „ „ „ Anterior view.

„ 11d. „ „ „ „ „ Posterior view.

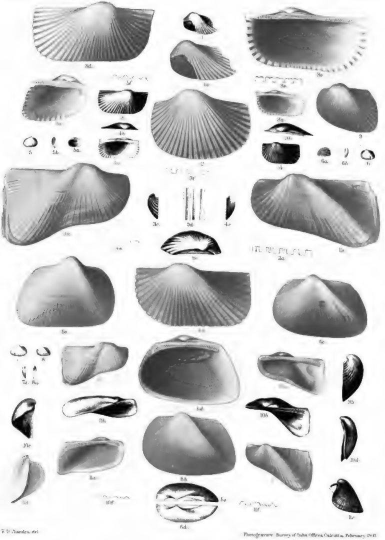
„ 11e. „ „ „ „ Enlarged.

„ 11f. „ „ „ „ Cross section of ribs, enlarged.

GEOLOGICAL SURVEY OF INDIA.

Dr. Noetling

Palæontologia Indica Memoir No 3 Pl VII



F. D. Chatsley del.

Photogravure. Survey of India Offices Calcutta, February 1900.

PLATE VIII.

Fig. 1. Cucullæa protoconcamerata, spec. nov. Right valve, nat. size. Thayetmyo, page 154.
„ 1a. „ „ „ „ Anterior view.
Fig. 2. Cucullæa protoconcamerata, spec. nov. Ornamentation, enlarged, page 154.
Fig. 3. Nucula alcocki, Noetling. Right valve, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 156.
„ 3a. „ „ „ „ „ Anterior view.
„ 3b. „ „ „ „ „ Dorsal view.
„ 3c. „ „ „ „ Anterior view, enlarged.
„ 3d. „ „ „ „ Dorsal view, enlarged.
Fig. 4. Nucula alcocki, Noetling. Right valve, nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 156.
„ 4a. „ „ „ „ Ornamentation enlarged.
Fig. 5. Nucula alcocki, Noetling. Left valve, nat. size. Internal view. Zone of *Cancellaria martiniana*, Minbu, page 156.
„ 5a. „ „ „ „ Enlarged.
Fig. 6. Nucula phayreiana, spec. nov. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 158.
„ 6a. „ „ „ „ „ Anterior view.
„ 6b. „ „ „ „ „ Dorsal view.
„ 6c. „ „ „ „ „ Posterior view.
Fig. 7. Nucula phayreiana, spec. nov. Left valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 158.
„ 7a. „ „ „ „ „ Anterior view.
„ 7b. „ „ „ „ „ Dorsal view.
„ 7c. „ „ „ „ „ Posterior view.
„ 7d. „ „ „ „ Internal view, enlarged.
Fig. 8. Leda virgo, K. Martin. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 160.
„ 8a. „ „ „ „ Anterior view.
„ 8b. „ „ „ „ Dorsal view.
„ 8c. „ „ „ Enlarged.
„ 8d. „ „ „ Dorsal view, enlarged.
Fig. 9. Leda virgo, K. Martin. Left valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 160.
„ 9a. „ „ „ „ Anterior view.
„ 9b. „ „ „ „ Dorsal view.
„ 9c. „ „ „ „ Enlarged.
„ 9d. „ „ „ „ Dorsal view, enlarged.
Fig. 10. Leda virgo, K. Martin. Left valve, internal view, nat. size. Zone of *Parallelipipedum, prototortuosum*, Kama, page 160.
„ 10a. „ „ „ „ Enlarged.
Fig. 11. Leda avaënsis, spec. nov. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 161.
„ 11a. „ „ „ „ Anterior view.
„ 11b. „ „ „ „ Dorsal view.
„ 11c. „ „ „ „ Enlarged.
Fig. 12. Leda birmanica, spec. nov. Right valve, nat. size. Zone of *Meiocardia protovulgaris*, Singu, page 159.

PLATE VIII—*concld.*

Fig. 13. CARDITA SCABROSA, d'Archiac and Haime. Right valve, nat. size. Zone of *Meiocardia metavulgaris*, Singu, page 162.

„ 13*a*. „ „ „ „ „ „ ventral view.

Fig. 14. CARDITA PROTOVARIEGATA, spec. nov. Right valve, nat. size. Zone of *Cytherea erycina*, Prome, page 164.

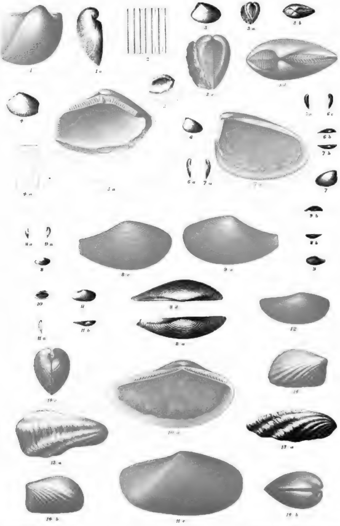
„ 14*a*. „ „ „ Left valve.

„ 14*b*. „ „ „ Dorsal view.

„ 14*c*. „ „ „ Anterior view.

GEOLOGICAL SURVEY OF INDIA

Dr. Noetling. Palæontologia Indica : Memoir No. 3 Pl. VIII.



K. D. Chandra, del. et lith. Printed at the Geol. Surv. of India Office.

PLATE IX.

Fig. 1. CARDITA PROTOVARIEGATA, spec. nov. Left valve, nat. size. Zone of *Cytherea erycina*, Prome, page 164.

„ 1*a*. „ „ „ „ Enlarged.

Fig. 2. CARDITA PROTOVARIEGATA, spec. nov. Right valve, nat. size. Zone of *Cytherea erycina*, Prome, page 164.

„ 2*a*. „ „ „ „ Enlarged.

Fig. 3. CARDITA PROTOVARIEGATA, spec. nov. Left valve, nat. size. Zone of *Parallelepipedum prototortuosum*, Kama, page 164.

„ 3*a*. „ „ „ „ „ Internal view.

„ 3*b*. „ „ „ „ „ Anterior view.

„ 3*c*. „ „ „ „ „ Internal view, enlarged.

Fig. 4. CARDITA PROTOVARIEGATA, spec. nov. Right valve. Internal view, enlarged, page 164.

Fig. 5. CARDITA TJIDAMARENSIS, K. Martin. Left valve, nat. size. Zone of *Meiocardia metavulgaris*, Singu, page 166.

„ 5*a*. „ „ „ „ Enlarged.

Fig. 6. CARDITA VIQUESNELI, d'Archiac and Haime. Right valve, nat. size. Zone of *Parallelepipedum prototortuosum*, Kama, page 167.

„ 6*a*. „ „ „ „ nat size. Internal view.

„ 6*b*. „ „ „ „ „ Dorsal view.

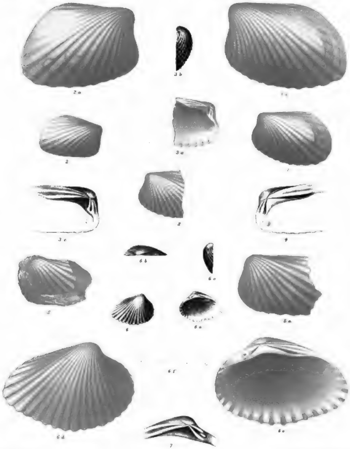
„ 6*c*. „ „ „ „ „ Anterior view.

„ 6*d*. „ „ „ „ Enlarged.

„ 6*e*. „ „ „ „ Internal view, enlarged.

„ 6*f*. „ „ „ „ Cross section of ribs, enlarged.

Fig. 7. CARDITA VIQUESNELI, d'Archiac and Haime. Left valve; hinge enlarged. Zone of *Parallelipipedum prototortuosum*, Kama, page 167.



K. D. Chunder, del. et lith. Printed at the Geol. Surv. of India Office.

PLATE X.

Fig. 1. CARDITA PLANICOSTATA, spec. nov. Left valve, nt. size. Zone of *Pholas orientalis*, Thayetmyo, page 170.
" 1a. " " " " " Cross section of ribs, enlarged.
Fig. 2. CARDITA cf. MUTABILIS, d'Archiac and Haime. Right valve, nat. size. Zone of *Meiocardia metavulgaris*, Singu, page 170.
Fig. 3. CRASSATELLA DIENERI, spec. nov. Right valve, nat. size. Zone of *Meiocardia metavulgaris*, Singu, page 171.
" 3a. " " " " Anterior view.
" 3b. " " " " Dorsal view.
" 3c. " " " " Internal view.
" 3d. " " " " Dorsal view, enlarged.
Fig. 4. CRASSATELLA ROSTRATA, Lamarck. Right valve, nat. size. Zone of *Aricia humerosa*, Thayetmyo, page 173.
Fig. 5. CRASSATELLA ROSTRATA, Lamarck. Right valve, nat. size. Zone of *Aricia humerosa*, Thayetmyo, page 173.
Fig. 6. LUCINA NEASQUAMOSA, spec. nov. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 174.
" 6a. " " " " " Internal view.
" 6b. " " " " " Anterior view.
" 6c. " " " " Enlarged.
" 6d. " " " " Internal view, enlarged.
Fig. 7. LUCINA PAGANA, spec. nov. Left valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 176.
" 7a. " " " " " Anterior view.
" 7b. " " " " " Enlarged.
Fig. 8. LUCINA PAGANA, spec. nov. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 176.
" 8a. " " " " " Anterior view.
" 8b. " " " " Interior view, enlarged.
Fig. 9. LUCINA D'ARCHIACIANA, spec. nov. Right valve, nat. size. Zone of *Dione dubiosa*, Yenangyat, page 177.
" 9a. " " " Left valve.
" 9b. " " " Anterior view.
" 9c. " " " Dorsal view.
Fig. 10. CARDIUM PROTOSUBRUGOSUM, spec. nov. Left valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 179.
" 10a. " " " " " Anterior view.
" 10b. " " " " " Dorsal view.
" 10c. " " " " Enlarged.
" 10d. " " " " Anterior view, enlarged.
" 10e. " " " " Posterior view, enlarged.

PLATE X—*concld.*

Fig. 11. CARDIUM PROTOSUBRUGOSUM, spec. nov. Left valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 179.

Fig. 12. CARDIUM MINBUENSE, spec. nov. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 181.

„ 12*a*. „ „ „ „ „ Anterior view.

„ 12*b*. „ „ „ „ „ Dorsal view.

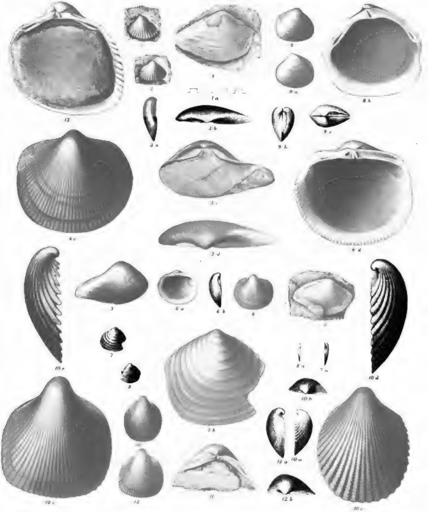
„ 12*c*. „ „ „ „ Enlarged.

Fig. 13. CARDIUM MINBUENSE, spec. nov. Right valve. Interior view, enlarged. Zone of *Parallelipipedum prototortuosum*, Kama, page 181.

GEOLOGICAL SURVEY OF INDIA

Dr. Noetling.

Palæontologia Indica : Memoir No.3 Pl. X.



K. D. Chandra, del. et lith

Printed at the Geol. Surv. of India Office.

PLATE XI.

Fig. 1. CYRENA KODOUNGENSIS, spec. nov. Right valve, nat. size. Zone of *Cyrena crawfurdi*, Yenangyoung, page 183

Fig. 2. CYRENA KODOUNGENSIS, spec. nov. Left valve, nat. size. Zone of *Cyrena crawfurdi*, Yenangyoung, page 183.

Fig. 3. CYRENA CRAWFURDI, Noetling. Right valve, nat. size. Zone of *Cyrena crawfurdi*, Yenangyoung, page 184.

" 3*a*. " " " " " Anterior view.

" 3*b*. " " " " " Dorsal view.

Fig. 4. CYRENA CRAWFURDI, Noetling. Right valve, nat. size. Zone of *Cyrena crawfurdi*, Yenangyoung, page 184.

" 4*a*. " " " Left valve.

" 4*b*. " " " Anterior view.

Fig. 5. CYRENA CRAWFURDI, Noetling. Right valve, nat. size. Zone of *Cyrena crawfurdi*, Yenangyoung, page 184.

" 5*a*. " " " " " Anterior view.

Fig. 6. CYRENA CRAWFURDI, Noetling. Right valve, nat. size. Zone of *Cyrena crawfurdi*, Yenangyoung, page 184.

" 6*a*. " " " " " Anterior view.

" 6*b*. " " " " " Dorsal view.

Fig. 7. CYRENA CRAWFURDI, Noetling. Left valve, nat. size. Hinge. Zone of *Cyrena crawfurdi*, Yenangyoung, page 184.

Fig. 8. CYRENA CRAWFURDI, Noetling. Right valve, nat. size. Hinge. Zone of *Cyrena crawfurdi*, Yenangyoung, page 184.

Fig. 9. CYRENA PETROLEI, Noetling. Right valve, nat. size. Zone of *Cyrena crawfurdi*, Yenangyoung, page 188.

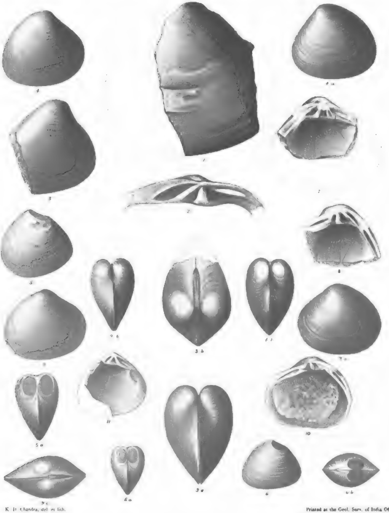
" 9*a*. " " " Left valve.

" 9*b*. " " " Anterior view.

" 9*c*. " " " Dorsal view.

Fig. 10. CYRENA PETROLEI, Noetling. Right valve, nat. size. Hinge. Zone of *Cyrena crawfurdi*, Yenangyoung, page 188.

Fig. 11. CYRENA PETROLEI, Noetling. Left valve, nat. size. Hinge. Zone of *Cyrena crawfurdi*, Yenangyoung, page 188.



K. P. Chandra, del. et lith. Printed at the Geol. Surv. of India Office.

PLATE XII.

Fig. 1. Meiocardia protovulgaris, spec. nov. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 191.

" 1*a*. " " " " " Internal view.

" 1*b*. " " " " " Anterior view.

" 1*c*. " " " " " Dorsal view.

" 1*d*. " " " " enlarged.

" 1*e*. " " " " internal view, enlarged.

Fig. 2. Meiocardia metavulgaris, spec. nov. Right valve, nat. size. Zone of *Meiocardia metavulgaris*, Singu, page 193.

" 2*a*. " " " Left valve.

" 2*b*. " " " Anterior view.

" 2*c*. " " " Dorsal view.

" 2*d*. " " " Enlarged.

Fig. 3. Meiocardia metavulgaris, spec. nov. Left valve, nat. size. Zone of *Meiocardia metavulgaris*, Singu, page 193.

" 3*a*. " " " " " Dorsal view.

Fig. 4. Petricola incerta, spec. nov. Left valve, nat. size. Zone of *Pholas orientalis*, Thayetmyo, page 194.

Fig. 5. Petricola incerta, spec. nov. Right valve, nat. size. Zone of *Pholas orientalis*, Thayetmyo, page 194.

Fig. 6. Venus protoflexuosa, spec. nov. Left valve, nat. size. Zone of *Pholas orientalis*, Thayetmyo, page 196.

" 6*a*. " " " " enlarged.

Fig. 7. Venus granosa, Sowerby. Left valve, nat. size. Thayetmyo, page 197.

" 7*a*. " " " Part of surface, enlarged.

Fig. 8. Cytherea erycina, Favanne. Right valve, nat. size. Zone of *Cytherea erycina*, Prome, page 198.

" 8*a*. " " " " " Anterior view.

Fig. 9. Cytherea erycina, Favanne. Left valve, nat. size. Zone of *Cytherea erycina*, Prome, page 198.

" 9*a*. " " " " " Anterior view.

Fig. 10. Cytherea erycina, Favanne. Right valve, nat. size. Zone of *Cytherea erycina*, Prome, page 198.

" 10*a*. " " " " " Anterior view.

Fig. 11. Cytherea erycina, Favanne. Left valve, nat. size. Zone of *Cytherea erycina*, Prome, page 198.

" 11*a*. " " " " " Anterior view.

Fig. 12. Cytherea erycina, Favanne. Last of right valve, nat. size. Zone of *Cytherea erycina*, Prome, page 198.

" 12*a*. " " " Left valve.

" 12*b*. " " " Anterior view.

Fig. 13. Cytherea yomaënsis, spec. nov. Right valve, nat. size. Zone of *Pholas orientalis*, Thayetmyo, page 200.

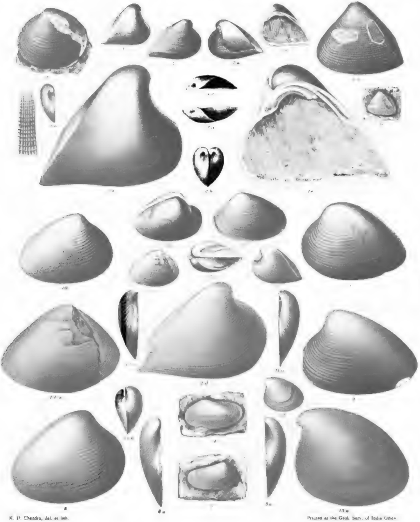
" 13*a*. " " " " enlarged.

Fig. 14. Dione protolilacina, spec. nov. Right valve, nat. size. Zone of *Parallelipipedum protortuosum*, Kama, page 202.

" 14*a* " " " " enlarged.

GEOLOGICAL SURVEY OF INDIA

Dr. Noetling. Palæontologia Indica : Memoir No. 3 Pl. XII



K. D. Chandra, del. et lith.

Printed at the Geol. Surv. of India Office.

PLATE XIII.

Fig. 1. DIONE PROTOLILACINA, Reeve. Left valve, nat. size. Zone of *Parallelipipedum protetortuosum*, Kama, page 202.

„ 1*a*. „ „ „ „ Internal view.

„ 1*b*. „ „ „ „ Anterior view

„ 1*c*. „ „ „ enlarged.

Fig. 2. DIONE ARRAKANENSIS, spec. nov. Left valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 204.

„ 2*a*. „ „ „ „ Internal view.

„ 2*b*. „ „ „ „ Anterior view.

„ 2*c*. „ „ „ „ Dorsal view.

„ 2*d*. „ „ „ „ enlarged.

„ 2*e*. „ „ „ „ internal view, enlarged.

Fig. 3. DIONE AMYGDALOIDES, spec. nov. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 205.

„ 3*a*. „ „ „ „ „ Internal view.

„ 3*b*. „ „ „ „ „ Anterior view.

Fig. 4. DIONE AMYGDALOIDES, spec. nov. Left valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 205.

„ 4*a*. „ „ „ „ „ Internal view.

„ 4*b*. „ „ „ „ „ Anterior view.

„ 4*c*. „ „ „ „ internal view, enlarged.

Fig. 5. DIONE PROTOPHILIPPINARUM, spec. nov., var. orbicularis. Right valve., nat size. Zone of *Parallelipipedum prototortuosum*, Kama, page 209.

„ 5*a*. „ „ „ „ Left valve.

„ 5*b*. „ „ „ „ Anterior view.

„ 5*c*. „ „ „ „ Dorsal view.

„ 5*d*. „ „ „ „ Enlarged

Fig. 6. DIONE PROTOPHILIPPINARUM, spec. nov., var. elongata. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 209.

„ 6*a*. „ „ „ „ Right valve, anterior view.

„ 6*b*. „ „ „ „ „ dorsal view.

„ 6*c*. „ „ „ „ „ internal view.

„ 6*d*. „ „ „ „ „ enlarged.

Fig. 7. DIONE PROTOPHILIPPINARUM, spec. nov., var. elongata. Left valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 209.

„ 7*a*. „ „ „ „ Left valve, anterior view.

„ 7*b*. „ „ „ „ „ dorsal view.

„ 7*c*. „ „ „ „ „ internal view.

„ 7*d*. „ „ „ „ „ internal view, enlarged.

Fig. 8. DIONE PROTOPHILIPPINARUM, spec. nov., var. orbicularis. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 209.

PLATE XIII—*concld.*

Fig. 8*a*. DIONE PROTOPHILIPPINARUM, spec. nov., var. orbicularis. Right valve, internal view, page 209.

„ 8*b*. „ „ „ „ „ anterior view.

Fig. 9. DIONE PROTOPHILIPPINARUM, spec. nov., var. orbicularis. Left valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 209.

„ 9*a*. „ „ „ var. orbicularis. Left valve, nat. size. Internal view.

„ 9*b*. „ „ „ „ „ „ Anterior view.

Fig. 10. DIONE PROTOPHILIPPINARUM, spec. nov., var elongata. Right valve, internal view, enlarged. Zone of *Parallelipipedum prototortuosum*, Kama, page 209.

Fig. 11. DIONE DUBIOSA, Noetling. Right valve, nat size. Zone of *Dione dubiosa*, Yenangyat, page 207.

„ 11*a*. „ „ „ Left valve.

„ 11*b*. „ „ „ Anterior view.

„ 11*c*. „ „ „ Dorsal view.

„ 11*d*. „ „ „ Right valve, enlarged.

„ 11*e*. „ „ „ Anterior view, enlarged.

Fig. 12. TAPES PROTOLIRATA, spec. nov. Right valve, nat size. Thayetmyo, page 212.

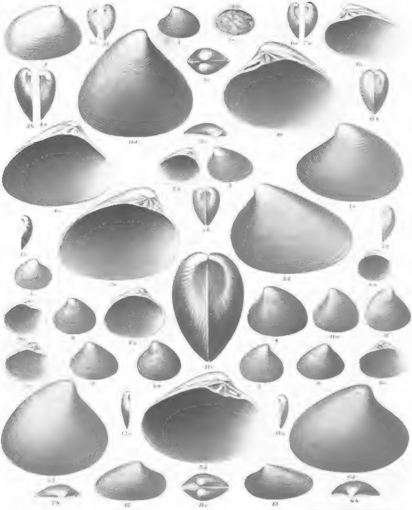
„ 12*a*. „ „ „ „ anterior view.

Fig. 13. TAPES PROTOLIRATA, spec. nov. Left valve, nat. size. Thayetmyo, page 212.

„ 13*a*. „ „ „ „ anterior view.

GEOLOGICAL SURVEY OF INDIA

Dr. Noetling. Palæontologia Indica : Memoir No.3 Pl.XIII

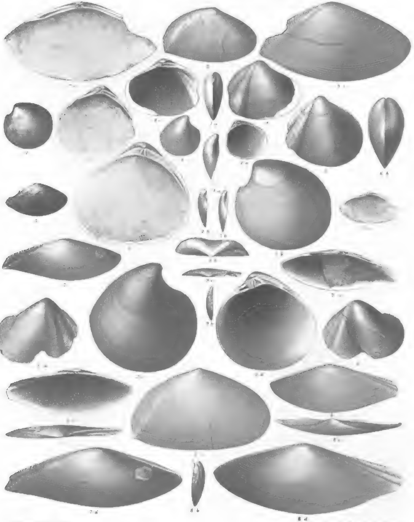


K. D. Chandra del. et lith.

Printed at the Geol. Surv. of India Office.

PLATE XIV.

Fig. 1. DOSINIA PROTOJUVENILIS, spec. nov. Left valve, nat. size. Thayetmyo, page 213.
„ 1a. „ „ „ „ „ Anterior view.
Fig. 2. DOSINIA PROTOJUVENILIS, spec. nov. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 213.
„ 2a. „ „ „ „ nat. size. Internal view.
„ 2b. „ „ „ „ „ Anterior view.
„ 2c. „ „ „ „ enlarged.
„ 2d. „ „ „ „ internal view, enlarged (other specimen).
Fig. 3. TELLINA (PHYLLODA) FOLIACEA, Reeve. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 222.
„ 3a. „ „ „ „ enlarged.
Fig. 4. TELLINA (METIS) GRIMESI, spec. nov. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 216.
„ 4a. „ „ „ „ „ Anterior view.
„ 4b. „ „ „ „ „ Dorsal view.
„ 4c. „ „ „ „ „ Internal view.
Fig. 5. TELLINA (METIS) GRIMESI, spec. nov. Right valve, nat. size. Zone of *Arca theobaldi*, Kama, page 216.
„ 5a. „ „ „ „ „ Internal view.
„ 5b. „ „ „ „ „ internal view, enlarged.
Fig. 6. TELLINA (METIS) GRIMESI, spec. nov. Right valve, nat. size. Zone of *Mytilus nicobaricus*, Singu, page 216.
„ 6a. „ „ „ „ „ Left valve.
„ 6b. „ „ „ „ „ Anterior view.
Fig. 7. TELLINA HILLI, Noetling. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 223.
„ 7a. „ „ „ „ „ Internal view.
„ 7b. „ „ „ „ „ Anterior view.
„ 7c. „ „ „ „ „ Dorsal view.
„ 7d. „ „ „ „ enlarged.
Fig. 8. TELLINA HILLI, Noetling. Left valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 223.
„ 8a. „ „ „ „ „ Internal view.
„ 8b. „ „ „ „ „ Anterior view.
„ 8c. „ „ „ „ „ Dorsal view.
„ 8d. „ „ „ „ enlarged.
Fig. 9. TELLINA PSEUDOHILLI, spec. nov. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 226.
„ 9a. „ „ „ „ „ Internal view.
„ 9b. „ „ „ „ „ Anterior view.
„ 9c. „ „ „ „ „ Dorsal view.
„ 9d. „ „ „ „ enlarged.
„ 9e. „ „ „ „ internal view, enlarged.



K. D. Chandra, del. et lith. Printed at the Geol. Surv. of India Office.

PLATE XV.

Fig. 1. TELLINA PROTOSTRIATULA, spec. nov. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 218.
„ 1*a*. „ „ „ Left valve.
„ 1*b*. „ „ „ Anterior view.

Fig. 2. TELLINA PROTOSTRIATULA, spec. nov. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 218.
„ 2*a*. „ „ „ Left valve.
„ 2*b*. „ „ „ Anterior view.
„ 2*c*. „ „ „ Dorsal view.
„ 2*d*. „ „ „ Right valve, enlarged.
„ 2*e*. „ „ „ Anterior view, enlarged.
„ 2*f*. „ „ „ Dorsal view, enlarged.

Fig. 3. TELLINA INDIFFERENS, spec. nov. Left valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 221.
„ 3*a*. „ „ „ „ „ Internal view.
„ 3*b*. „ „ „ „ „ Anterior view.

Fig. 4. TELLINA PROTOCANDIDA, spec. nov. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 219.
„ 4*a*. „ „ „ „ „ Anterior view.
„ 4*b*. „ „ „ „ enlarged.

Fig. 5. TELLINA PROTOCANDIDA, spec. nov. Left valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 219.
„ 5*a*. „ „ „ „ „ Anterior view.
„ 5*b*. „ „ „ „ „ Internal view.

Fig. 6. GARI NATENSIS, spec. nov. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 228.
„ 6*a*. „ „ „ Left valve.
„ 6*b*. „ „ „ „ Anterior view.
„ 6*c*. „ „ „ Right valve, enlarged.

Fig. 7. GARI PROTOKINGI, spec. nov. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 230.
„ 7*a*. „ „ „ „ „ Internal view.
„ 7*b*. „ „ „ „ „ Anterior view.
„ 7*c*. „ „ „ „ enlarged.
„ 7*d*. „ „ „ „ Internal view, enlarged.

Fig. 8. GARI PROTOKINGI, spec. nov. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 230.
„ 8*a*. „ „ „ „ „ Anterior view.
„ 8*b*. „ „ „ „ „ Dorsal view.
„ 8*c*. „ „ „ „ enlarged.

Fig. 9. GARI PROTOKINGI, spec. nov. Left valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 230.
„ 9*a*. „ „ „ „ „ Anterior view.
„ 9*b*. „ „ „ „ „ Dorsal view.
„ 9*c*. „ „ „ „ enlarged.

PLATE XV—*contd.*

Fig. 10. GARI DEUTEROKINGI, spec. nov. Left valve, nat. size. Zone of *Mytilus nicobaricus*, Singu, page 233.

„ 10*a*. „ „ „ „ „ Dorsal view.

„ 10*b*. „ „ „ „ enlarged.

Fig. 11. GARI KINGI, Noetling. Right valve, nat. size. Zone of *Meiocardia metavulgaris*, Singu, page 232.

„ 11*a*. „ „ „ „ enlarged.

Fig. 12. GARI KINGI, Noetling. Left valve, nat. size. Zone of *Meiocardia metavulgaris*, Singu, page 232.

„ 12*a*. „ „ „ „ enlarged.

Fig. 13. GARI KINGI, Noetling. Left valve, nat. size. Zone of *Meiocardia metavulgaris*, Singu, page 232.

„ 13*a*. „ „ „ „ enlarged.

Fig. 14. HIATULA TEXTILIS, spec. nov. Left valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 234.

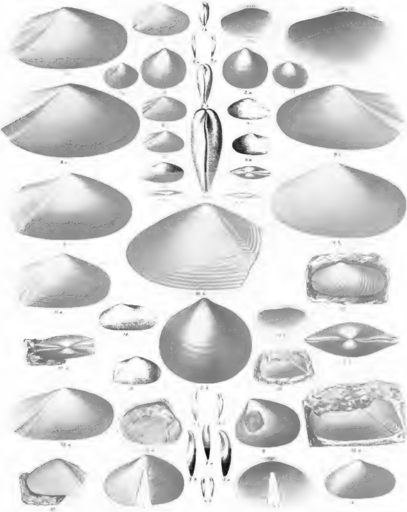
„ 14*a*. „ „ „ „ „ Internal view.

„ 14*b*. „ „ „ „ „ Anterior view.

Fig. 15. SOLECURTUS EXSULCATUS, spec. nov. Left valve, nat. size. Thayetmyo, page 235.

GEOLOGICAL SURVEY OF INDIA

Dr. Noetling. Palæontologia Indica : Memoir No. 3 Pl. XV



K. D. Chandra, del. et lith. Printed at the Geol. Surv. of India Office

PLATE XVI.

Fig. 1. Mactra protoreevesii, spec. nov. Right valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 236.

" 1*a*. " " " " " Internal view.

" 1*b*. " " " " " Anterior view.

" 1*c*. " " " " " Dorsal view.

" 1*d*. " " " " enlarged.

Fig. 2. Mactra protoreevesii, spec. nov. Left valve, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 236.

" 2*a*. " " " " " Internal view.

" 2*b*. " " " " " Anterior view.

" 2*c*. " " " " " Dorsal view.

" 2*d*. " " " " enlarged.

Fig. 3. Corbula socialis, K. Martin. Right valve, nat. size. Zone of *Arca theobaldi*, Kama, page 239.

" 3*a*. " " " " " Internal view.

" 3*b*. " " " " " Anterior view.

" 3*c*. " " " " " Dorsal view.

" 3*d*. " " " " enlarged.

" 3*e*. " " " " Internal view, enlarged.

Fig. 4. Corbula socialis, K. Martin. Right valve, nat. size. Zone of *Arca theobaldi*, Kama, page 239.

" 4*a*. " " " " " Anterior view.

" 4*b*. " " " " " Dorsal view.

Fig. 5. Corbula socialis, K. Martin. Left valve, nat. size. Zone of *Arca theobaldi*, Kama, page 239.

" 5*a*. " " " " " Internal view.

" 5*b*. " " " " " Anterior view.

" 5*c*. " " " " " Dorsal view.

" 5*d*. " " " " enlarged.

" 5*e*. " " " " Internal view, enlarged.

Fig. 6. Corbula prototruncata, spec. nov. Right valve, nat. size. Zone of *Arca theobaldi*, Kama, page 245.

" 6*a*. " " " " " Internal view.

" 6*b*. " " " " " Anterior view.

" 6*c*. " " " " " Dorsal view.

" 6*d*. " " " " enlarged.

" 6*e*. " " " " Internal view, enlarged.

Fig. 7. Corbula prototruncata, spec. nov. Right valve, nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 245.

" 7*a*. " " " Left valve.

" 7*b*. " " " Anterior view.

" 7*c*. " " " Right valve, enlarged.

" 7*d*. " " " Lelt valve, enlarged

Fig. 8. Corbula rugosa, Sowerby. Right valve, nat. size. Zone of *Meiocardia metavulgaris*, Singu, page 245.

" 8*a*. " " " " enlarged

PLATE XVI—*concld.*

Fig. 9. CORBULA RUGOSA, Sowerby. Right valve, nat. size. Zone of *Meiocardia metavulgaris*, Singu, page 243.

„ 9*a*. „ „ „ „ enlarged.

Fig. 10. CORBULA RUGOSA, Sowerby. Left valve, nat. size. Zone of *Mytilus nicobaricus*, Singu, page 243.

„ 10*a*. „ „ „ „ enlarged.

Fig. 11. PHOLAS ORIENTALIS, Gmelin. Right valve, nat. size. Zone of *Pholas orientalis*, Thayetmyo, page 248.

„ 11*a*. „ „ „ „ enlarged.

Fig. 12. PHOLAS ORIENTALIS, Gmelin. Left valve, nat. size. Zone of *Pholas orientalis*, Thayetmyo, page 248.

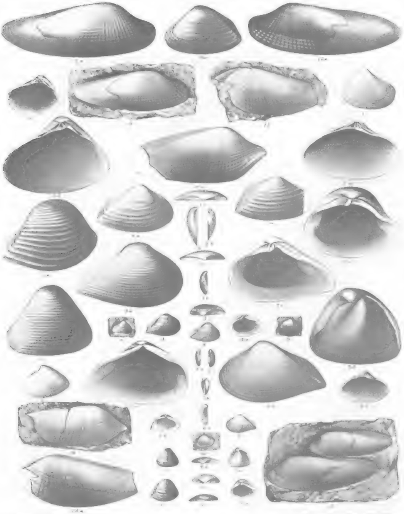
„ 12*a*. „ „ „ „ enlarged.

Fig. 13. PHOLAS BLANFORDIANUS, spec. nov. Right valve, nat. size. Zone of *Pholas orientalis*, Thayetmyo, page 248.

„ 13*a*. „ „ „ „ enlarged.

Fig. 14. PHOLAS BLANFORDIANUS, spec. nov. Left valve, nat. size. Zone of *Pholas orientalis*, Thayetmyo, page 248.

„ 14*a*. „ „ „ „ enlarged.



Printed at the Geol. Surv. of India Office.

PLATE XVII.

Fig. 1. DENTALIUM JUNGHUHNI, K. Martin, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 250.
" 1*a*. " " enlarged.
" 1*b*. " " Transversal section, enlarged.
Fig. 2. DENTALIUM JUNGHUHNI, K. Martin, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 250.
Fig. 3. DENTALIUM JUNGHUHNI, K. Martin, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 250.
" 3*a*. " " " enlarged.
" 3*b*. " " " Transversal section, enlarged.
Fig. 4. DENTALIUM BOETTGERI, spec. nov., nat. size. Zone of *Arca theobaldi*, Kama, page 251.
" 4*a*. " " " enlarged.
" 4*b*. " " " Transversal section, enlarged.
Fig. 5. CALLIOSTOMA BLANFORDI, Noetling, nat. size. Zone of *Meiocardia metavulgaris*, Singu, page 253.
Fig. 6. CALLIOSTOMA BLANFORDI, Noetling, nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 253.
" 6*a* " " " " Basal view.
Fig. 7. CALLIOSTOMA BLANFORDI, Noetling, nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 253.
" 7*a*. " " " " Basal view.
Fig. 8. CALLIOSTOMA BLANFORDI, Noetling, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 253.
" 8*a*. " " " " Basal view.
" 8*b*. " " " " Enlarged.
" 8*c*. " " " " Basal view, enlarged.
Fig. 9. TURCICA PROTOMONILIFERA, spec. nov., nat. size. Zone of *Meiocardia metavulgaris*, Singu, page 257.
" 9*a*. " " " " Basal view.
" 9*b*. " " " enlarged.
Fig. 10. TURCICA PROTOMONILIFERA, spec. nov., nat. size. Zone of *Arca theobaldi*, Kama, page 257.
" 10*a*. " " " " Basal view.
" 10*b*. " " " enlarged.
" 10*c*. " " " Basal view, enlarged.
" 10*d*. " " " Aperture, enlarged.
Fig. 11. BASILISSA LORIOLIANA, spec. nov., nat. size. Zone of *Meiocardia metavulgaris*, Singu, page 256.
Fig. 12. BASILISSA LORIOLIANA, spec. nov., nat. size. Zone of *Mytilus nicobaricus*, Singu, page 256.
Fig. 13. BASILISSA LORIOLIANA, spec. nov., nat. size. Zone of *Arca theobaldi*, Kama, page 256.
" 13*a*. " " " " Basal view.
" 13*b*. " " " enlarged.
" 13*c*. " " " Basal view, enlarged.
Fig. 14. CALLIOSTOMA KOENENIANUM, spec. nov., nat. size. Zone of *Arca theobaldi*, Kama, page 254.
" 14*a*. " " " " Basal view.
" 14*b*. " " " " Enlarged.

PLATE XVII—*concld.*

Fig. 15. CALLIOSTOMA KOERNENIANUM, spec. nov., nat. size. Zone of *Arca theobaldi*, Kama, page 254.

" 15*a*. " " " Basal view, enlarged.

Fig. 16. TROCHUS (ZIZYPHINUS), spec. nov., nat. size. Zone of *Cytherea erycina*, Promo, page 258.

" 16*a*. " " " " Basal view.

Fig. 17. SOLARIUM MAXIMUM, Phillipi, nat. size. Apical view. Zone of *Parallelipipedum prototortuosum*, Kama, page 261.

" 17*a*. " " " " Basal view.

" 17*b*. " " " " Lateral view.

" 17*c*. " " " " Apical view, enlarged.

" 17*d*. " " " " Basal view, enlarged.

Fig. 18. SOLARIUM NITENS, spec. nov., nat. size. Apical view. Zone of *Pholas orientalis*, Thayetmyo, page 259.

" 18*a*. " " " " enlarged.

Fig. 19. SOLARIUM CONIFORME, spec. nov., nat. size. Apical view. Zone of *Aricia humerosa*, Thayetmyo, page 263.

" 19*a*. " " " " Lateral view.

" 19*b*. " " " Apical view, enlarged.

Fig. 20. TORINIA BUDDHA, Noetling, nat. size. Apical view. Zone of *Cancellaria martiniana*, Minbu, page 265.

" 20*a*. " " " " Basal view.

" 20*b*. " " " "

" 20*c*. " " " Basal view, enlarged.

" 20*d*. " " " Apical view, enlarged.

Fig. 21. TORINIA BUDDHA, Noetling, nat. size. Apical view. Zone of *Cancellaria martiniana*, Minbu, page 265.

" 21*a*. " " " " Basal view.

" 21*b*. " " " "

" 21*c*. " " " Basal view, enlarged.

Fig. 22. TORINIA PROTODORSUOSA, spec. nov., nat. size. Apical view. Zone of *Arca theobaldi*, Kama, page 264.

" 22*a*. " " " " Basal view.

" 22*b*. " " " " Apical view.

" 22*c*. " " " " Apical view enlarged.

" 22*d*. " " " " Basal view, enlarged.

" 22*e*. " " " " Lateral view, enlarged.

Fig. 23. DISCOHELIX MINUTA, Noetling, nat. size. Apical view. Zone of *Cancellaria mratiniana*, Minbu, page 266.

" 23*a*. " " " " Basal view.

" 23*b*. " " " " Lateral view.

" 23*c*. " " " " Apical view, enlarged.

" 23*d*. " " " " Lateral view, enlarged.

Fig. 24. SCALARIA LEPTOPLEURATA, spec. nov., nat. size. Zone of *Dione dubiosa*, Yenangyat, page 269.

" 24*a*. " " " enlarged.

Fig. 25. SCALARIA BIRMANICA, Noetling, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 269.

" 25*a*. " " " enlarged.

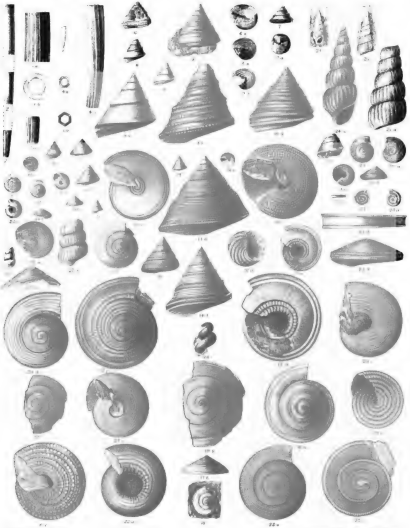
Fig. 26. SCALARIA (?) IRREGULARIS, Noetling, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 270.

Fig. 27. SCALARIA SPATHICA, spec. nov., nat. size. Zone of *Cancellaria martiniana*, Minbu page 268.

" 27*a*. " " " enlarged.

GEOLOGICAL SURVEY OF INDIA

Dr. Noetling. Palæontologia Indica : Memoir No.3 Pl.XVII



K. D. Chandra, del. et lith. Printed at the Geol. Surv. of India Office.

PLATE XVIII.

Fig. 1. TURRITELLA SIMPLEX, Jenkins, nat. size. Zone of *Arca theobaldi*, Kama, page 273.
„ 1a. „ „ „ „
Fig. 2. TURRITELLA SIMPLEX, Jenkins, nat. size. Zone of *Arca theobaldi*, Kama, page 273.
„ 2a. „ „ „ „
Fig. 3. TURRITELLA SIMPLEX, Jenkins, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 273.
„ 3a. „ „ „ enlarged.
Fig. 4. TURRITELLA SIMPLEX, Jenkins, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 273.
„ 4a. „ „ „ enlarged.
Fig. 5. TURRITELLA ACUTICARINATA, Dunker, nat. size. Zone of *Arca theobaldi*, Kama, page 274.
„ 5a. „ „ „ „
„ 5b. „ „ „ „ Enlarged.
Fig. 6. TURRITELLA ACUTICARINATA, Dunker, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 274.
Fig. 7. TURRITELLA ACUTICARINATA, Dunker, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 274.
„ 7a. „ „ „ enlarged.
Fig. 8. TURRITELLA, spec., nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 277.
„ 8a. „ „ „ Enlarged.
Fig. 9. TURRITELLA AFFINIFORMIS, spec. nov., nat. size. Zone of *Cancellaria martiniana*, Minbu, page 277.
„ 9a. „ „ „ enlarged.
Fig. 10. TURRITELLA LEIOPLEURATA, spec. nov., nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 278.
„ 10a. „ „ „ enlarged.
Fig. 11. TURRITELLA LYDEKKERI, spec. nov., nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 276.
Fig. 12. TURRITELLA LYDEKKERI, spec. nov., nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 276.
„ 12a. „ „ „ enlarged.
Fig. 13. TURRITELLA ANGULATA, Sowerby, nat. size. Thayetmyo, page 272.
„ 14. TURRITELLA ANGULATA, Sowerby, nat. size. Thayetmyo, page 272.
Fig. 15. TURRITELLA ANGULATA, Sowerby, nat. size. Thayetmyo, page 272.
„ 15a. „ „ „ enlarged.
Fig. 16. VERMETUS JAVANUS, K. Martin, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 279.
„ 16a. „ „ „ „
„ 16b. „ „ „ „
Fig. 17. VERMETUS JAVANUS, K. Martin, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 279.
„ 17a. „ „ „ „
„ 17b. „ „ „ „
Fig. 18. VERMETUS JAVANUS, K. Martin, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 279.
„ 18a. „ „ „ „

PLATE XVIII—*concld.*

Fig. 19. VERMETUS JAVANUS, K. Martin, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 279.

„ 19*a*. „ „ „ „ enlarged.

Fig. 20. SILIQUARIA, spec. 1, nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 280.

„ 20*a*. „ „ enlarged.

Fig. 21. XENOPHORA BIRMANICA, spec. nov., nat. size. Zone of *Aricia humerosa*, Thayetmyo, page 280.

„ 21*a*. „ „ „ „

Fig. 22. CALYPTRAEA RUGOSA, Noetling, nat. size. Zone of *Arca theobaldi*, Kama, page 281.

„ 22*a*. „ „ „ „

„ 22*b*. „ „ „ enlarged.

Fig. 23. CALYPTRAEA RUGOSA, Noetling, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 281.

„ 23*a*. „ „ „ „

„ 23*b*. „ „ „ apical view, enlarged.

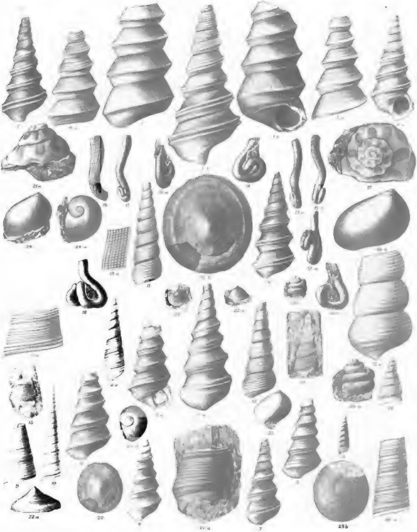
Fig. 24. NATICA CALLOSA, Sowerby, nat. size. Zone of *Aricia humerosa*, Thayetmyo, page 283.

„ 24*a*. „ „ „ „ apical view.

„ 24*b*. „ „ „ lateral view, enlarged.

Fig. 25. NATICA CALLOSA, Sowerby, nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 283.

„ 25*a*. „ „ „ „ apical view.

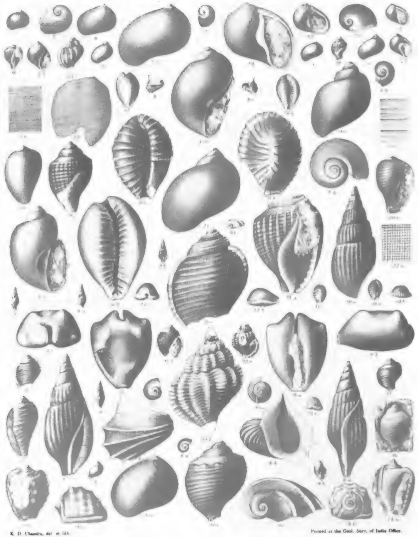


K. D. Chandra, del. et lith. Printed at the Geol. Surv. of India Office

PLATE XIX.

Fig. 1. NATICA CALLOSA, Sowerby, nat. size. Zone of *Arca theobaldi*, Kama, page 283.
„ 1a. „ „ „
„ 1b. „ „ „
„ 1c. „ „ „ enlarged.
„ 1d. „ „ „ „
Fig. 2. NATICA OBSCURA, Sowerby, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 284.
„ 2a. „ „ „ „
„ 2b. „ „ „ „
Fig. 3. NATICA OBSCURA, Sowerby, nat. size. Zone of *Arca theobaldi*, Kama, page 284.
„ 3a. „ „ „ „
„ 3b. „ „ „ „
„ 3c. „ „ „ enlarged.
„ 3d. „ „ „ enlarged.
Fig. 4. NATICA GRACILIOR, spec. nov., nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 285.
„ 4a. „ „ „
„ 4b. „ „ „
„ 4c. „ „ enlarged.
„ 4d. „ „ „
„ 4e. „ „ „
Fig. 5. NATICA, spec., nat. size. Zone of *Arca theobaldi*, Kama, page 286.
„ 5a. „ „ enlarged.
Fig. 6. SIGARETUS NERITOIDEUS, Linné, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 286.
„ 6a. „ „ „ „
„ 6b. „ „ „ „
Fig. 7. SIGARETUS NERITOIDEUS, Linné, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 286.
„ 7a. „ „ „ enlarged.
Fig. 8. FOSSARUS KRAUSEI, spec. nov., nat. size. Zone of *Arca theobaldi*, Kama, page 287.
„ 8a. „ „ „ „
„ 8b. „ „ „ „
„ 8c. „ „ „ enlarged.
„ 8d. „ „ „ „
„ 8e. „ „ „ „
Fig. 9. RIMELLA CRISPATA, Sowerby, spec., nat. size. Zone of *Arca theobaldi*, Kama, page 288.
„ 9a. „ „ „ „
„ 9b. „ „ „ „
„ 9c. „ „ „ enlarged.
„ 9d. „ „ „ „
Fig. 10. RIMELLA CRISPATA, Sowerby, nat. size. Zone of *Arca theobaldi*, Kama, page 288.
„ 10a. „ „ „ enlarged.
Fig. 11. ARICIA HUMEROSA, J. de Carle Sowerby, spec., nat. size. Zone of *Aricia humerosa* Thayetmyo, page 291.
„ 11a. „ „ „ „ „
„ 11b. „ „ „ „ „
„ 11c. „ „ „ „ „

Fig. 12. CYPRÆA GRANTI, d'Archiac and Haime, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 290.
„ 12*a*. „ „ „ „ „
„ 12*b*. „ „ „ „ „
„ 12*c*. „ „ „ „ „
„ 12*d*. „ „ „ „ enlarged.
Fig. 13. TRIVIA SMITHI, K. Martin, nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 293.
„ 13*a*. „ „ „ „
„ 13*b*. „ „ „ „
„ 13*c*. „ „ „ „
„ 13*d*. „ „ „ enlarged.
„ 13*e*. „ „ „ „
Fig. 14. CASSIS D'ARCHIACI, Noetling, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 294.
„ 14*a*. „ „ „ „
„ 14*b*. „ „ „ „
„ 14*c*. „ „ „ „
Fig. 15. SEMICASSIS PROTOJAPONICA, spec. nov., nat. size. Zone of *Cancellaria martiniana*, Minbu, page 295.
„ 15*a*. „ „ „ „
„ 15*b*. „ „ „ „
„ 15*c*. „ „ „ enlarged.
Fig. 16. GALEODEA MONILIFERA, spec. nov., nat. size. Zone of *Mytilus nicobaricus*, Singu, page 297.
Fig. 17. GALEODEA MONILIFERA, spec. nov., nat. size. Zone of *Arca theobaldi*, Kama, page 297.
„ 17*a*. „ „ „ enlarged.
Fig. 18. ONISCIDIA MINBUENSIS, spec. nov., nat. size. Zone of *Cancellaria martiniana*, Minbu, page 297.
„ 18*a*. „ „ „ enlarged.
Fig. 19. ONISCIDIA MINBUENSIS, spec. nov., nat. size. Zone of *Cancellaria martiniana*, Minbu, page 297.
„ 19*a*. „ „ „ enlarged.
Fig. 20. FICULA THEOBALDI, Noetling, nat. size. Zone of *Mytilus nicobaricus*, Singu, page 298.
„ 20*a*. „ „ „ „
Fig. 21. FICULA THEOBALDI, Noetling, nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 298.
„ 21*a*. „ „ „ „ ornamentation, enlarged.
Fig. 22. FICULA, spec., nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 299.
„ 22*a*. „ „ ornamentation, enlarged.
Fig. 23. CANCELLARIA DAVIDSONI, d'Archiac and Haime, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 331.
„ 23*a*. „ „ „ „ „
„ 23*b* „ „ „ „ „ enlarged.



K. D. Chandra, del. et lith.

Printed at the Geol. Surv. of India Office.

PLATE XX.

Fig. 1. CANCELLARIA DAVIDSONI, d'Archiac and Haime, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 331.
„ 1a. „ „ „ „ „
„ 1b. „ „ „ „ „
„ 1c. „ „ „ „ enlarged.
Fig. 2. TRITON NEASTRIATULUS, spec. nov., nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 301.
„ 2a. „ „ „ „
„ 2b. „ „ „ „ enlarged.
„ 2c. „ „ „ „ „
Fig. 3. TRITON NEASTRIATULUS, spec. nov., nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 301.
„ 3a. „ „ „ „ enlarged.
Fig. 4. TRITON NEACOLUBRINUS, spec. nov., nat. size. Zone of *Arca theobaldi*, Kama, page 304.
„ 4a. „ „ „ „
„ 4b. „ „ „ enlarged.
„ 4c. „ „ „ „
„ 4d. „ „ „ „
Fig. 5. TRITON PARDALIS, Noetling, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 302.
„ 5a. „ „ „ „
„ 5b. „ „ „ enlarged.
„ 5c. „ „ „ „
Fig. 6. PERSONA GAUTAMA, spec. nov., nat. size. Zone of *Arca theobaldi*, Kama, page 305.
„ 6a. „ „ „ „
„ 6b. „ „ „ „
„ 6c. „ „ „ „ enlarged.
„ 6d. „ „ „ „ „
„ 6e. „ „ „ „ „
Fig. 7. PERSONA GAUTAMA, spec. nov., nat. size. Zone of *Arca theobaldi*, Kama, page 305.
„ 7a. „ „ „ „ enlarged.
Fig. 8. RANELLA PROTOTUBERCULARIS, spec. nov., nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 306.
„ 8a. „ „ „ „
„ 8b. „ „ „ „
„ 8c. „ „ „ enlarged.
„ 8d. „ „ „ „
Fig. 9. RANELLA PROTOTUBERCULARIS, spec. nov., nat. size. Zone of *Cancellaria martiniana*, Minbu, page 306.
„ 9a. „ „ „ „
„ 9b. „ „ „ „
„ 9c. „ „ „ enlarged.
„ 9d. „ „ „ „
Fig. 10. RANELLA ELEGANS, Beck, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 309.
„ 10a. „ „ „ „
„ 10b. „ „ „ „

PLATE XX—*concld.*

Fig. 11. EBURNA PROTOZEYLANICA, spec. nov., nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 310.

" 11*a*. " " " "

Fig. 12. FUSUS SEMINUDUS, spec. nov., nat. size. Zone of *Cancellaria martiniana*, Minbu, page 312.

" 12*a*. " " " "

" 12*b*. " " " enlarged.

Fig. 13. FUSUS SEMINUDUS, spec. nov., nat. size. Zone of *Cancellaria martiniana*, Minbu, page 312.

" 13*a*. " " " "

" 13*b*. " " " enlarged.

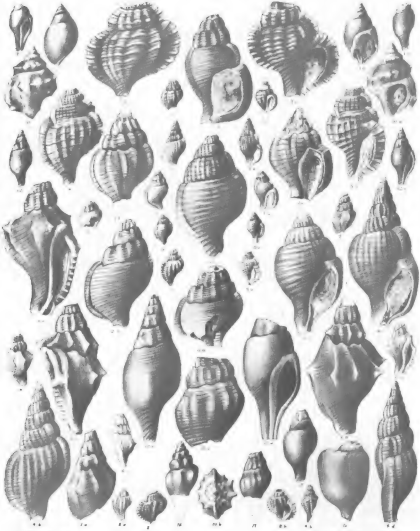
Fig. 14. FUSUS (CLAVELLA) (?) VERBECKI, K. Martin, nat. size. Zone of *Aricia humerosa*, Thayetmyo, page 313.

Fig. 15. FUSUS (CLAVELLA) (?) VERBECKI, K. Martin, nat. size. Zone of *Aricia humerosa*, Thayetmyo, page 313.

Fig. 16. FASCIOLARIA NODULOSA, J. de Carle Sowerby, nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 314.

Fig. 17. FASCIOLARIA NODULOSA, J. de Carle Sowerby, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 314.

" 17*a*. " " " " enlarged.



K. D. Chandra, del. et lith. Printed at the Geol. Surv. of India Office.

PLATE XXI.

Fig. 1. FASCIOLARIA NODULOSA, J. de Carle Sowerby, nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 314.

" 1a. " " " "

" 1b. " " " enlarged.

Fig. 2. PYRULA PUGILINA, Born. spec., nat. size. Zone of *Cytherea erycina*, Prome, page 315.

" 2a. " " " " apical view.

Fig. 3. PYRULA BUCEPHALA, Lamarck, nat. size. Zone of *Mytilus nicobaricus*, Singu, page 317.

" 3a. " " " "

Fig. 4. PYRULA BUCEPHALA, Lamarck, nat. size. Zone of *Mytilus nicobaricus*, Singu, page 317.

" 4a. " " " "

Fig. 5. PYRULA PSEUDOBUCEPHALA, spec. nov., nat. size. Zone of *Mytilus nicobaricus*, Singu, page 318.

Fig. 6. PYRULA PSEUDOBUCEPHALA, spec. nov., nat. size. Zone of *Mytilus nicobaricus*, Singu, page 318.

" 6a. " " " "

Fig. 7. MUREX ARRAKANENSIS, Noetling, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 319.

" 7a. " " " "

" 7b. " " " "

" 7c. " " " "

" 7d. " " " enlarged.

" 7e. " " " "

Fig. 8. MUREX TCHIHATCHEFFI, d'Archiac and Haime, nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 320.

" 8a. " " " " enlarged.

Fig. 9. MUREX TCHIHATCHEFFI, d'Archiac and Haime, nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 320.

" 9a. " " " " "

Fig. 10. MARGINELLA (GLABELLA) SCRIPTA, nat. size. Zone of *Arca theobaldi*, Kama, page 321.

" 10a. " " " "

" 10b. " " " enlarged.

" 10c. " " " "

Fig. 11. VOLVARIA BIRMANICA, Noetling, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 322.

" 11a. " " " "

" 11b. " " " enlarged.

" 11c. " " " "

Fig. 12. VOLUTA RINGENS, spec. nov., nat. size. Zone of *Cancellaria martiniana*, Minbu, page 323.

" 12a. " " " "

" 12b. " " " enlarged.

Fig. 13. VOLUTA RINGENS, spec. nov., nat. size. Zone of *Cancellaria martiniana*, Minbu, page 323.

Fig. 14. VOLUTA DENTATA, J. de Carle Sowerby, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 324.

" 14a. " " " "

" 14b. " " " "

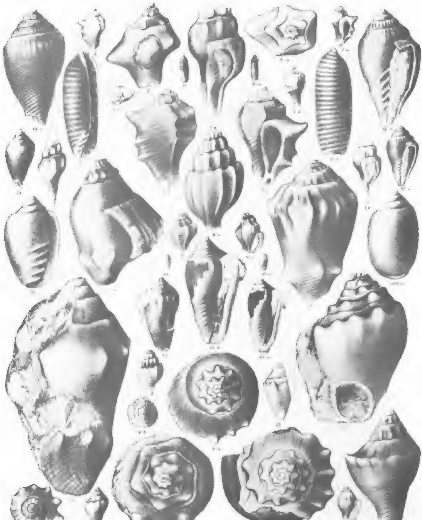
" 14c. " " " enlarged.

" 14d. " " " "

Fig 15. VOLUTA DENTATA, J. de Carle Sowerby, nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 324.

" 15a. " " " "

" 15b " " " enlarged



K. D. Chandra, del. et lith. Printed at the Geol. Surv. of India Office.

PLATE XXII.

Fig. 1. VOLUTA DENTATA, J. de Carle Sowerby, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 324.

„ 1a. „ „ „ enlarged.

Fig. 2. VOLUTA DENTATA, J. de Carle Sowerby, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 324.

„ 2a. „ „ „ enlarged.

Fig. 3. VOLUTA DENTATA, J. de Carle Sowerby, nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 324.

„ 3a. „ „ „ enlarged.

Fig. 4. OLIVA (STREPHONA) RUFULA, Duclos, nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 326.

„ 4a. „ „ „ „ enlarged.

„ 4b. „ „ „ „ „

„ 4c. „ „ „ „ „

Fig. 5. OLIVA (STREPHONA) RUFULA, Duclos., nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 326.

„ 5a. „ „ „ „ enlarged.

Fig. 6. ANCILLARIA, spec. cf. *vernedei*, Sowerby, nat. size Zone of *Cytherea erycina*, Promo, page 327.

Fig. 7. CANCELLARIA NEAVOLUTELLA, spec. nov., nat. size. Zone of *Arca theobaldi*, Kama, page 328.

„ 7a. „ „ „

„ 7b. „ „ „ enlarged.

Fig. 8. CANCELLARIA NEAVOLUTELLA, spec. nov., nat. size. Zone of *Arca theobaldi*, Kama, page 328.

„ 8a. „ „ „ enlarged.

Fig. 9. CANCELLARIA INORNATA, spec. nov, nat. size. Zone of *Arca theobaldi*, Kama, page 329.

„ 9a. „ „ „ „

„ 9b. „ „ „ enlarged.

„ 9c. „ „ „ „ „

Fig. 10. CANCELLARIA PSEUDOCANCELLATA, Lamarck, nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 330.

„ 10a. „ „ „

„ 10b. „ „ „ enlarged.

„ 10c. „ „ „ „

Fig. 11. CANCELLARIA MARTINIANA, spec. nov., nat. size. Zone of *Cancellaria martiniana*, Minbu, page 332.

„ 11a. „ „ „ „

„ 11b. „ „ „ enlarged.

„ 11c. „ „ „ „

„ 11d. „ „ „ „

Fig. 12. CANCELLARIA MARTINIANA, spec. nov., nat. size. Zone of *Cancellaria martiniana*, Minbu, page 332.

„ 12a. „ „ „ „

PLATE XXII—*concld.*

Fig. 13. CANCELLARIA MARTINIANA, spec. nov., nat. size. Zone of *Cancellaria martiniana*, Minbu, page 332.

„ 13*a*. „ „ „ „

„ 13*b*. „ „ „ enlarged.

„ 13*c*. „ „ „ „

Fig. 14. STRIOTEREBRUM PROTOMYUROS, nat. size. Zone of *Arca theobaldi*, Kama, page 335.

„ 14*a*. „ „ ornamentation enlarged.

Fig. 15. STRIOTEREBRUM BICINCTUM, K. Martin, nat. size. Zone of *Arca theobaldi*, Kama, page 337.

„ 15*a*. „ „ ornamentation enlarged.

Fig. 16. STRIOTEREBRUM UNICINCTUM, K. Martin, nat. size. Zone of *Arca theobaldi*, Kama, page 336.

„ 16*a*. „ „ ornamentation enlarged.

Fig. 17. TEREBRUM PROTODUPLICATUM, spec. nov., nat. size. Zone of *Arca theobaldi*, Kama, page 338.

„ 17*a*. „ „ ornamentation enlarged.

Fig. 18. TEREBRUM SMITHI, K. Martin, nat. size. Zone of *Cancellaria martiniana*, Kama, page 339.

„ 18*a*. „ „ „ enlarged.

Fig. 19. TEREBRUM, spec., nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 340.

„ 19*a*. „ „ enlarged.

Fig. 20. SUBULA, spec., nat. size. Zone of *Cancellaria martiniana*, Minbu, page 341.

Fig. 21. PLEUROTOMA (s. s.) KARENAICA spec. nov., nat. size. Zone of *Arca theobaldi*, Kama, page 344.

„ 21*a*. „ „ „ „ enlarged.

Fig. 22. SURCULA FEDDENI, Noetling, nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 346.

„ 22*a*. „ „ „ „ enlarged.

Fig. 23. SURCULA FEDDENI, Noetling, nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 346.

„ 23*a*. „ „ „ „ enlarged.

Fig. 24. SURCULA FEDDENI, Noetling, nat. size. Zone of *Arca theobaldi*, Kama, page 346.

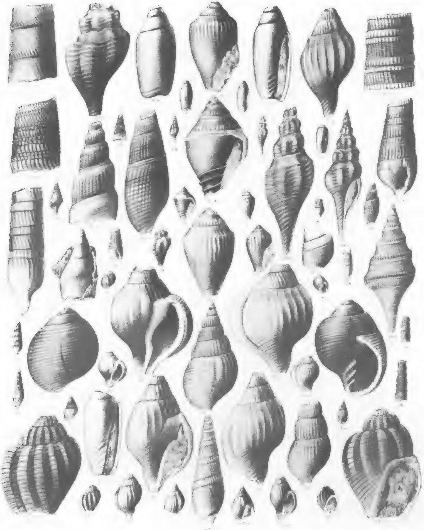
„ 24*a*. „ „ „ „ enlarged.

Fig. 25. GENOTA IRRAVADICA, Noetling, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 347.

„ 25*a*. „ „ „ „ enlarged.

Fig. 26. GENOTA IRRAVADICA, Noetling, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 347.

„ 26*a*. „ „ „ „ enlarged.



K. B. Chandra, del. et lith. Printed at the Geol. Surv. of India Office

PLATE XXIII.

Fig. 1. Clavatula munga, spec. nov., nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 347.
„ 1a. „ „ ornamentation of spire whorls enlarged.
Fig. 2. Clavatula fulminata, Kiener, nat. size. Zone of *Mytilus nicobaricus*, Singu, page 349.
„ 2a. „ „ „ enlarged.
Fig. 3. Clavatula protonodifera, spec. nov., nat. size. Zone of *Cancellaria martiniana*, Minbu, page 350.
„ 3a. „ „ enlarged.
Fig. 4. Clavatula protonodifera, spec. nov., nat. size. Zone of *Mytilus nicobaricus*, Singu, page 350.
„ 4a. „ „ „ enlarged.
Fig. 5. Drillia yenanensis, spec. nov., nat. size. Zone of *Paracyathus caeruleus*, page 353.
„ 5a. „ „ „ enlarged.
Fig. 6. Drillia protocincta, spec. nov., nat. size. Zone of *Arca theobaldi*, Kama, page 356.
„ 6a. „ „ „ enlarged.
Fig. 7. Drillia protocincta, spec. nov., nat. size. Zone of *Arca theobaldi*, Kama, page 356.
„ 7a. „ „ „ enlarged.
Fig. 8. Drillia protointerrupta, spec. nov., nat. size. Zone of *Cancellaria martiniana*, Minbu, page 354.
„ 8a. „ „ „ enlarged.
Fig. 9. Drillia protointerrupta, spec. nov., nat. size. Zone of *Arca theobaldi*, Kama, page 354.
„ 9a. „ „ „ enlarged.
Fig. 10. Drillia protointerrupta, spec. nov., nat. size. Zone of *Arca theobaldi*, Kama, page 354.
„ 10a. „ „ „ enlarged.
Fig. 11. Drillia promensis, spec. nov., nat. size. Zone of *Arca theobaldi*, Kama, page 355.
„ 11a. „ „ „ enlarged.
Fig. 12. Conus literatus, Linné, nat. size. Zone of *Aricia humerosa*, Thayetmyo, page 359.
Fig. 12a. „ „ „
Fig. 13. Conus literatus, Linné, nat. size. Zone of *Aricia humerosa*, Thayetmyo, page 359.
„ 13a. „ „ „ „
Fig. 14. Conus literatus, Linné, nat. size. Zone of *Aricia humerosa*, Thayetmyo, page 359.
Fig. 15. Conus avaënsis, spec. nov., nat. size. Zone of *Mytilus nicobaricus*, Singu, page 362.
„ 15a. „ „ „ „
„ 15b. „ „ „ „
Fig. 16. Conus avaënsis, spec. nov., nat. size. Zone of *Cytherea erycina*, Prome, page 362.
„ 16a. „ „ „ „
„ 16b. „ „ „ „
Fig. 17. Conus malaccanus, Hwass, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 360.
„ 17a. „ „ „ „
Fig. 18. Conus malaccanus, Hwass, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 360.
„ 18a. „ „ „ „ enlarged.
„ 18b. „ „ „ „ „
Fig. 19. Conus malaccanus, Hwass, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 360.
„ 19a. „ „ „ „ enlarged.

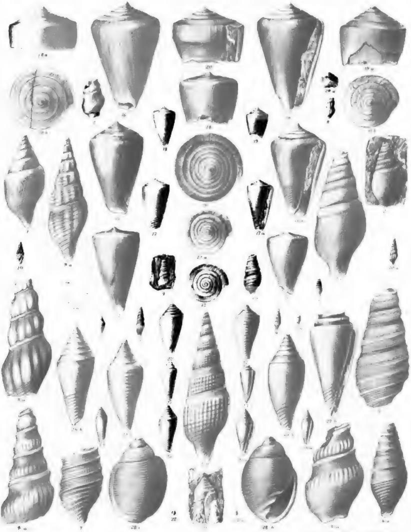
PLATE XXIII—*concld.*

Fig. 20. CONUS MALACCANUS, Hwass, nat. size. Zone of *Cancellaria martiniana*, Minbu, page 360.
„ 20*a*. „ „ „ enlarged.
Fig. 21. CONUS YULEIANUS, spec. nov., nat. size. Zone of *Aricia humerosa*, Thayetmyo, page 363.
Fig. 22. CONUS YULEIANUS, spec. nov., nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 363.
Fig. 23. CONUS HANZA, spec. nov., nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 364.
Fig. 24. CONUS HANZA, spec. nov., nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 364.
„ 24*a*. „ „ „ enlarged.
Fig. 25. CONUS PROTOFURVUS, spec. nov., nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 365.
„ 25*a*. „ „ „ „
„ 25*b*. „ „ „ enlarged.
Fig. 26. CONUS PROTOFURVUS, spec. nov., nat. size. Zone of *Arca theobaldi*, Kama, page 365.
„ 26*a*. „ „ „ „
„ 26*b*. „ „ „ enlarged.
Fig. 27. CONUS GALENSIS, spec. nov., nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 366.
„ 27*a*. „ „ „ „
„ 27*b*. „ „ „ enlarged.
Fig. 28. RINGICULA TURRITA, K. Martin, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 367.
„ 28*a*. „ „ „ „
„ 28*b*. „ „ „ enlarged.
„ 28*c*. „ „ „ „

GEOLOGICAL SURVEY OF INDIA

Dr. Noetling.

Palæontologia Indica : Memoir No. 3 Pl. XXIII



K. D. Chandra, del. et lith.

Printed at the Geol. Surv. of India Office.

PLATE XXIV.

Fig. 1. BALANUS TINTINNABULUM, Linné, nat. size. Horizon unknown, Thayetmyo, page 368.

Fig. 2. BALANUS TINTINNABULUM, Linné, nat. size. Horizon unknown, Thayetmyo, page 368.

Fig. 3. CALLIANASSA BIRMANICA, spec. nov. Left hand, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 368.

„ 3a. „ „ „ „ „ Internal side.

„ 3b. „ „ „ „ „ Lower side.

Fig. 4. CALLIANASSA BIRMANICA, spec. nov. Left hand, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 368.

„ 4a. „ „ „ „ „ External.

„ 4b. „ „ „ „ „ Lower side.

„ 4c. „ „ „ „ „ Proximal end.

„ 4d. „ „ „ „ „ Distal end.

„ 4e. „ „ „ „ Internal side, enlarged.

Fig. 5. CALLIANASSA BIRMANICA, spec. nov. Right hand, nat. size. Zone of *Parallelipipedum prototortuosum*, Kama, page 368.

„ 5a. „ „ „ „ „ External side.

„ 5b. „ „ „ „ „ Lower side.

„ 5c. „ „ „ „ „ Proximal end.

„ 5d. „ „ „ „ „ Distal end.

Fig. 6. CALAPPA PROTOPUSTULOSA, spec. nov., nat. size. Horizon unknown, Thayetmyo, page 369.

„ 6a. „ „ „ „ Lateral view.

„ 6b. „ „ „ „ Enlarged.

Fig. 7. EBALIA TUBERCULATA, spec. nov., nat. size. Horizon unknown, Thayetmyo, page 370.

„ 7a. „ „ „ enlarged.

Fig. 8. NEPTUNUS, spec. Right hand, nat. size. External side. Horizon unknown, Thayetmyo, page 371.

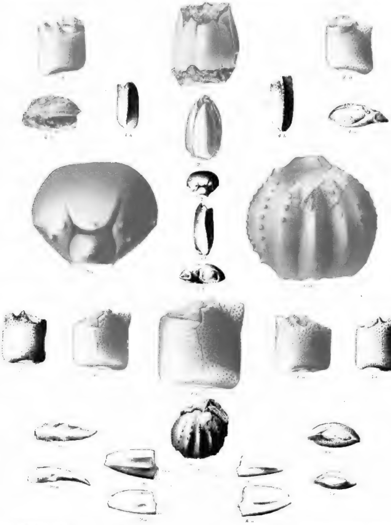
„ 8a. „ „ „ Internal side.

Fig. 9. NEPTUNUS, spec. Horizon unknown, Thayetmyo, page 371.

„ 9a. „ „ „ „

Fig. 10. CANCER, spec. Horizon unknown, Thayetmyo, page 371.

„ 10a. „ „ „ „



K. D. Chatterji, del. et lith.

Printed at the Geol. Surv. of India Office.

PLATE XXV.

Fig.	1.	OXYRHINA PAGODA,	spec. nov.	Median tooth,	nat. size.		External side, Thayetmyo, page 372.
„	1a.	„	„	„	„	„	Internal side.
„	1b.	„	„	„	„	„	Lateral view.
„	1c.	„	„	„	„	enlarged.	Internal side.
„	1d.	„	„	„	„	„	External side.
„	1e.	„	„	„	„	„	Lateral view.
Fig.	2.	OXYRHINA PAGODA,	spec. nov.	Lateral tooth,	nat. size.		External side, Thayetmyo, page 372.
„	2a.	„	„	„	„	„	Internal side.
„	2b.	„	„	„	„	„	Lateral view.
„	2c.	„	„	„	„	enlarged.	Internal side.
„	2d.	„	„	„	„	„	External side.
„	2e.	„	„	„	„	„	Lateral view.
Fig.	3.	OXYRHINA PAGODA,	spec. nov.	Lateral tooth,	nat. size.		External side, Thayetmyo, page 372.
„	3a.	„	„	„	„	„	Internal side.
„	3b.	„	„	„	„	„	Lateral view.
Fig.	4.	OXYRHINA SPALLANZANII,	Bon.	Median tooth,	nat. size.		Internal side. Zone of *Cancellaria martiniana*, Minbu, page 372.
Fig.	5.	OXYRHINA SPALLANZANII,	Bon.	Median tooth,	nat. size.		Internal side. Zone of *Cancellaria martiniana*, Minbu, page 372.
„	5a.	„	„	„	„	„	External side.
„	5b.	„	„	„	„	„	Lateral view.
„	5c.	„	„	„	„	enlarged.	Internal side.
„	5d.	„	„	„	„	„	External side.
„	5e.	„	„	„	„	„	Lateral view.
Fig.	6.	OXYRHINA SPALLANZANII,	Bon.	Lateral tooth,	nat. size.		Internal side. Zone of *Cancellaria martiniana*, Minbu, page 372.
„	6a.	„	„	„	„	„	External side.
„	6b.	„	„	„	„	„	Lateral view.
„	6c.	„	„	„	„	enlarged.	Internal side.
„	6d.	„	„	„	„	„	External side.
„	6e.	„	„	„	„	„	Lateral view.
Fig.	7.	ALOPIAS VULPES,	Gmelin,	nat. size.			Internal side, Thayetmyo, page 373.
„	7a.	„	„	„	„		External side.
„	7b.	„		„	enlarged.		Internal side.
„	7c.	„	„	„	„		External side.
Fig.	8.	CARCHARODON MEGALODON,	Agassiz,	nat. size.			Internal side, Thayetmyo, page 374
„	8a.	„	„	„	„		External side
Fig.	9.	HEMIPRISTIS SERRA,	Agassiz.	Median tooth,	nat. size.		Internal side, Thayetmyo, page 374.
„	9a.	„	„	„	„	„	External side.
„	9b.	„	„	„	„	„	Lateral view.
„	9c.	„	„	„	„	enlarged.	Internal side.
„	9d.	„	„	„	„	„	External side.
„	9e.	„	„	„	„	„	Lateral view.
Fig.	10.	HEMIPRISTIS SERRA,	Agassiz.	Lateral tooth,	nat. size.		Thayetmyo, page 374.

PLATE XXV—*concld.*

Fig. 11. Carcharias (Prionodon) gangeticus, M. & H. Lateral tooth, nat. size. Internal side, Thayetmyo, page 375.

,, 11*a*. ,, ,, ,, ,, ,, nat. size. External side.

,, 11*b*. ,, ,, ,, ,, ,, ,, Lateral view.

,, 11*c*. ,, ,, ,, ,, ,, enlarged. Internal side.

,, 11*d*. ,, ,, ,, ,, ,, ,, External side.

,, 11*e*. ,, ,, ,, ,, ,, ,, Lateral view.

Fig. 12. Carcharias (Prionodon) gangeticus, M. & H. Lateral tooth, nat. size. Internal side, Thayetmyo, page 375.

,, 12*a*. ,, ,, ,, ,, ,, nat. size. External side.

,, 12*b*. ,, ,, ,, ,, ,, ,, Lateral view.

Fig. 13. Carcharias (Prionodon) gangeticus, M. & H. Lateral tooth, nat. size. Internal side, Thayetmyo, page 375.

,, 13*a*. ,, ,, ,, ,, ,, nat. size. External side.

,, 13*b*. ,, ,, ,, ,, ,, ,, Lateral view.

Fig. 14. Carcharias (Prionodon) gangeticus, M. & H. Median tooth, nat. size. Internal side, Thayetmyo, page 375.

,, 14*a*. ,, ,, ,, ,, ,, nat. size. External side.

,, 14*b*. ,, ,, ,, ,, ,, ,, Lateral view.

Fig. 15. Carcharias (Prionodon) gangeticus, M. & H. Median tooth, nat. size. Internal side, Thayetmyo, page 375.

,, 15*a*. ,, ,, ,, ,, ,, nat. size. External side.

,, 15*b*. ,, ,, ,, ,, ,, ,, Lateral view.

Fig. 16. Galeocerdo, spec., nat. size. Zone of *Cancellaria martiniana*, Minbu, page 375.

Fig. 17. Myliobates, spec., nat. size. Thayetmyo, page 376.

Fig. 18. Myliobates, spec., nat. size. Zone of *Cancellaria martiniana*, Minbu, page 376.

,, 18*a*. ,, ,, ,, Lower side.

,, 18*b*. ,, ,, ,, Cross section.

Fig. 19. Otolithus, spec., nat. size. Zone of *Paracyathus caeruleus*, Yenangyat, page 376.

,, 19*a*. ,, ,, ,,

Fig. 20. Siluroid. gen., nat. size. Zone of *Anoplotherium birmanicum*, Yenangyoung, page 377.

,, 20*a*. ,, ,, ,,

Fig. 21. Python cf. molurus, Linné, nat. size. Zone of *Anoplotherium birmanicum*, Yenangyoung, page 377.

,, 21*a*. ,, ,, ,, ,, Lateral view.

Fig. 22. Crocodilus palustris, Less., nat. size. Zone of *Anoplotherium birmanicum*, Yenangyoung, page 378.

,, 22*a*. ,, ,, ,, ,, Lateral view.

,, 22*b*. ,, ,, ,, enlarged

Fig. 23. Gharialis gangeticus, Gmel., nat. size. Zone of *Anoplotherium birmanicum*, Yenangyoung, page 377.

,, 23*a*. ,, ,, ,, ,, Lateral view.

,, 23*b*. ,, ,, ,, enlarged. Lateral view.

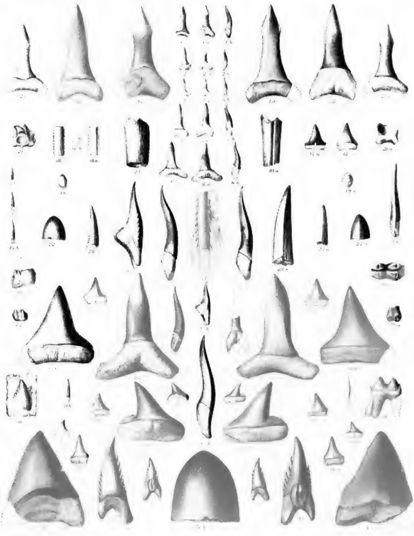
Fig 24. Anoplotherium birmanicum, spec. nov., nat. size. Zone of *Anoplotherium birmanicum*, Yenangyoung, page 378.

,, 24*a*. ,, ,, ,,

Fig. 25. Anoplotherium birmanicum, spec. nov., nat. size (?). Zone of *Anoplotherium birmanicum*, Yenangyoung, page 375.

,, 25*a*. ,, ,, ,,

Dr. Noetling. Palæontologia Indica : Memoir No. 3 Pl. XXV



K. D. Chatterji, lith. delin. Printed at the Geol. Surv. of India Office.

RECORDS OF THE GEOLOGICAL SURVEY OF INDIA.

VOLS. I TO XXX, 1868 TO 1897.

The price fixed for these publications is 1 rupee (2*s.*) each part, or 2 rupees (4*s.*) each volume.

NOTE.—*The Records ceased to be published from the 1st January 1898.*

MISCELLANEOUS PUBLICATIONS.

A Manual of the Geology of India. 4 Vols. With map. 1879-1887—
  Vol. 1. Peninsular Area.
  Vol. 2. Extra-Peninsular Area. } By H. B. Medlicott and W. T. Blanford. Price 8 rupees (*out of print*).
  Vol. 3. Economic Geology. By V. Ball. Price 5 rupees (*out of print*).
  Vol. 4. Mineralogy. By F. R. Mallet. Price 2 rupees.
A Manual of the Geology of India, 2nd edition. By R. D. Oldham (1893). Price 8 rupees.
A Manual of the Geology of India, Economic Geology, by the late Prof. V. Ball, 2nd edition, revised in parts
  Part I.—Corundum. By T. H. Holland (1898). Price 1 rupee.
Popular guides to the geological collections in the Indian Museum, Calcutta—
  No. 1. Tertiary vertebrate animals. By R. Lydekker. 1879. Price 2 annas (*out of print*).
  No. 2. Minerals. By F. R. Mallet (1879). Price 2 annas (*out of print*).
  No. 3. Meteorites. By F. Fedden (1880). Price 2 annas.
  No. 4. Palæontological collections. By O. Feistmantel (1881). Price 2 annas.
  No. 5. Economic mineral products. By F. R. Mallet (1883). Price 2 annas (*out of print*).

Descriptive catalogue of the collection of Minerals in the Geological Museum, Calcutta. By F. R. Mallet (1883). Price 2 rupees.

An Introduction to the Chemical and Physical study of Indian Minerals. By T. H. Holland (1895). Price 8 annas.

Catalogue of the remains of Siwalik Vertebrata contained in the Geological Department of the Indian Museum. By R. Lydekker, Pt. I. Mammalia (1885). Price 1 rupee. Pt. II. Aves, Reptilia, and Pisces (1886). Price 4 annas.

Catalogue of the remains of Pleistocene and Pre-Historic Vertebrata contained in the Geological Department of the Indian Museum. By R. Lydekker (1886). Price 4 annas.

Bibliography of Indian Geology. By R. D. Oldham (1888). Price 1 rupee 8 annas.

Report on the Geological Structure and Stability of the Hill slopes around Naini Tal. By T. H. Holland (1897). Price 3 rupees.

Report on the Inspection of Mines in India, for the year ending 30th June 1894. By James Grundy (1894). Price 1 rupee.

Report on the Inspection of Mines in India for the year ending 30th June 1895. By James Grundy (1896). Price 2 rupees.

Report on the Inspection of Mines in India for the year ending 30th June 1896. By James Grundy (1897). Price 1 rupee.

Report on the Inspection of Mines in India for the year ending 31st December 1896. By James Grundy (1897). Price 1 rupee.

Report on the Inspection of Mines in India for the year ending 31st December 1897. By James Grundy (1898). Price 1 rupee 8 annas.

Report on the Inspection of Mines in India for the year ending 31st December 1898. By James Grundy (1899) Price 12 annas.

Report on the Inspection of Mines in India for the year ending 31st December 1899. By G. F. Reader, from notes by J. Grundy (1901). Price 8 annas.

Geological map of India, 1893. Scale 1" = 96 miles. Price 1 rupee.

To be had on application to the Registrar, Geological Survey of India, Calcutta.—London Kegan Paul, Trench, Trübner & Co.

PALÆONTOLOGIA INDICA:

(SERIES I, III, V, VI, VIII.)

CRETACEOUS FAUNA OF SOUTHERN INDIA, *by* F. STOLICZKA, *except* VOL. I, PT. 1, *by* H. F. BLANFORD.

VOL. I. The Cephalopoda (1861—65), pp. 216, pls. 94 (6 double).
  „ II. The Gastropoda (1867—68), pp. xiii, 500, pls. 28.
  „ III. The Pelecypoda (1870—71), pp. xxii, 537, pls. 50.
  „ IV. The Brachiopoda, Ciliopoda, Echinodermata, Corals, etc. (1872—73), pp. v, 202, pls. 29.

(SERIES II, XI, XII.)

THE FOSSIL FLORA OF THE GONDWANA SYSTEM, *by* O. FEISTMANTEL, *except* VOL. I, PT. 1, *by* T. OLDHAM *and* J. MORRIS.

VOL. I, pp. xviii, 233, pls. 72. 1863—79. Pt. 1; Rájmahál Group, Rájmahál Hills. Pt. 2; *The same (continued)*. Pt. 3; Plants from Golapilli. Pt. 4; Outliers on the Madras Coast.
  „ II, pp. xli, 115, pls. 26. 1876—78. Pt. 1; Jurassic Flora of Kach. Pt. 2; Flora of the Jabalpur Group.
  „ III, pp. xi, 64 + 149, pls. 80 (9 double) (I—XXXI + IA—XLVIIA). 1879—81. Pt. 1; The Flora of the Talchir-Karharbari beds. Pt. 2; The Flora of the Damuda and Panchet Divisions. Pt. 3; *The same (concluded)*.
  „ IV, pp. xxvi, 25 + 66, pls. 35 (2 double) (I—XXV + IA—XIVA). Pt. 1 (1882), Fossil Flora of the South Rewah Gondwana basin. Pt. 2 (1886); Fossil Flora of some of the Coal-fields in Western Bengal.

PALÆONTOLOGIA INDICA—*continued.*

(SERIES IX.)

JURASSIC FAUNA OF KACH.

VOL. I (1873–76). The Cephalopoda, by W. WAAGEN, pp. i, 247, pls. 60 (6 double).
„ II, pt. 1 (1893). The Echinoidea of Kach, by J. W. GREGORY, pp. 12, pls. 2.
„ „ „ 2 (1900). The Corals, by J. W. GREGORY, pp. 195, i–ix, pls. 26.
„ III „ 1 (1900). The Brachiopoda, by F. L. KITCHIN, pp. 87, pls. 15.

(SERIES IV.)

INDIAN PRE-TERTIARY VERTEBRATA.

VOL. I, pp. vi, 137, pls. 26. 1865–85. Pt. 1 (1865); The Vertebrate Fossils from the Panchet rocks, by T. H. HUXLEY. Pt. 2 (1878); The Vertebrate Fossils of the Kota-Maleri Group, by SIR P. DE M. GREY EGERTON and L. C. MIALL. Pt. 3 (1879); Reptilia and Batrachia, by R. LYDEKKER. Pt. 4 (1885): The Labyrinthodont from the Bijori Group, by R. LYDEKKER. Pt. 5 (1885); The Reptilia and Amphibia of the Maleri and Denwa groups, by R. LYDEKKER.

(SERIES X.)

INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA, *by* R. LYDEKKER, *except* VOL. I, PT. 1, *by* R. B. FOOTE.

VOL. I, pp. xxx, 300, pls. 50. 1874–80. Pt. 1; Rhinoceros deccanensis. Pt. 2; Molar teeth and other remains of Mammalia. Pt. 3; Crania of Ruminants. Pt. 4; Supplement to Pt. 3. Pt. 5; Siwalik and Narbada Proboscidia.
„ II, pp. xv, 363, pls. 45. 1881–84. Pt. 1; Siwalik Rhinocerotidæ. Pt. 2; Supplement to Siwalik and Narbada Proboscidia. Pt. 3; Siwalik and Narbada Equidæ. Pt. 4; Siwalik Camelopardalidæ. Pt. 5; Siwalik Selenodont Suina, etc. Pt. 6; Siwalik and Narbada Carnivora.
„ III, pp. xxiv, 264, pls. 38. 1884–86. Pt. 1; Additional Siwalik Perissodactyla and Proboscidia. Pt. 2; Siwalik and Narbada Bunodont Suina. Pt. 3; Rodents and new Ruminants from the Siwaliks. Pt. 4; Siwalik Birds. Pt. 5; Mastodon Teeth from Perim Island. Pt. 6; Siwalik and Narbada Chelonia. Pt. 7; Siwalik Crocodilia, Lacertilia and Ophidia. Pt. 8; Tertiary Fishes.
„ IV, Pt. 1, 1886. Siwalik Mammalia (Supplement 1), pp. 18, pls. 6.
„ „ Pt. 2, 1886. The Fauna of the Karnul caves (and addendum to Pt. 1); pp. 40 (19–58), pls. 5 (vii–xi).
„ „ Pt. 3, 1887. Eocene Chelonia from the Salt-range; pp. 7 (59–65), pls. 2 (xii–xiii).

(SERIES XIII.)

SALT-RANGE FOSSILS, *by* WILLIAM WAAGEN, PH.D.

Productus-Limestone Group: Vol. I, Pt. 1 (1879). Pisces, Cephalopoda, pp. 72, pls. 6.
„ „ „ 2 (1880). Gastropoda and Supplement to Pt. 1, pp. 111 (73–183), pls. 10 (1 double), (vii–xvi).
„ „ „ 3 (1881). Pelecypoda, pp. 144 (185–328), pls. 8 (xvii–xxiv).
„ „ „ 4 (1882–85). Brachiopoda, pp. 442 (329–770), pls. 62 (xxv–lxxxvi).
„ „ „ 5 (1885). Bryozoa—Annelidæ—Echinodermata, pp. 64 (771–834), pls. 10 (lxxxvii–xcvi).
„ „ „ 6 (1886). Cœlenterata, pp. 90 (835–924), pls. 20 (xcvii–cxvi).
„ „ „ 7 (1887). Cœlenterata, Protozoa, pp. 74 (925–998), pls. 12 (cxvii–cxxviii).
Fossils from the Ceratite Formation: Vol. II, pt. 1 (1895). Pisces—Ammonoidea, pp. 324, pls. 40.
Geological Results: Vol. IV, Pt. 1 (1889), pp. 1–88, pls. 4.
„ „ „ „ 2 (1891), pp. 89–242, pls. 8.

(SERIES VII, XIV.)

TERTIARY AND UPPER CRETACEOUS FAUNA OF WESTERN INDIA, *by* P. MARTIN DUNCAN *and* W. PERCY SLADEN, *except* PT. 1, *by* F. STOLICZKA.

VOL. I, pp. 16+110+382+91=599, pls. 5+28+58+13=104. 1871–85. Pt. 1; Tertiary Crabs from Sind and Kach. Pt. 1 (new 2); Sind Fossil Corals and Alcyonaria. Pt. 3; The Fossil Echinoidea of Sind: *Fas. 1.* The *Cardita beaumonti* beds; *Fas. 2.* The Ranikot series in Western Sind; *Fas. 3.* The Kirthar Series; *Fas. 4.* The Nari (Oligocene). Series; *Fas. 5,* The Gaj (Miocene) Series; *Fas. 6.* The Makrán (Pliocene) Series. Pt. 4; The Fossil Echinoidea of Kach and Kattywar.

(SERIES XV.)

HIMALAYAN FOSSILS, *by* CARL DIENER, PH.D.

The Anthracolithic Fossils of Kashmir and Spiti. Vol. I, Pt. 2 (1899), pp. 95, pls. 8.
The Permo-carboniferous Fauna of Chitichun No. I: Vol. I. Pt. 3 (1897), pp. 105, pls. 13.
The Permian Fossils of the Productus Shales of Kumaon and Gurhwal: Vol. I, Pt. 4 (1897), pp. 54, pls. 5.
The Cephalopoda of the Lower Trias: Vol. II, Pt. 1 (1897), pp. 182, pls. 23.
The Cephalopoda of the Muschelkalk: Vol. II, Pt. 2 (1895), pp. 118, pls. 31.
Upper Triassic Cephalopoda Fauna of the Himaláyas, by Dr. Edmund von Mojsisovics: Vol. III, Pt. 1 (1899), pp. 158, pls. 22.
Trias Brachiopoda and Lamellibranchiata, by Dr. Alexander Bittner: Vol. III, Pt. 2 (1899), pp. 76, pls. 12 (1 double).

(SERIES XVI.)

BALUCHISTAN FOSSILS, *by* FRITZ NOETLING, PH.D., F.G.S.

The Fauna of the Kellaways of Mazár Drik: Vol. I, Pt. 1 (1895), pp. 22, pls. 13.
The Fauna of the (Neocomian) Belemnite Beds: Vol. I, Pt. 2 (1897), pp. 5, pls. 2.
The Fauna of the Upper Cretaceous (Maëstrichtien) Beds of the Mari Hills: Vol. I, Pt. 3 (1897), pp. 79, pls. 23.

(NEW SERIES.)

Vol. I, 1. (1899), pp. 14, pl. 1: The Cambrian Fauna of the Eastern Salt-range, by K. Redlich, Ph.D.
„ „ 2. (1899), pp. 58, pls. 4: Notes on the Morphology of the Pelecypoda, by Fritz Noetling, Ph.D., F.G.S.

The price fixed for these publications is 4 annas (6 pence) per single plate.